# IRON AND STEEL ENGINEER

J. F. KELLY, Editor

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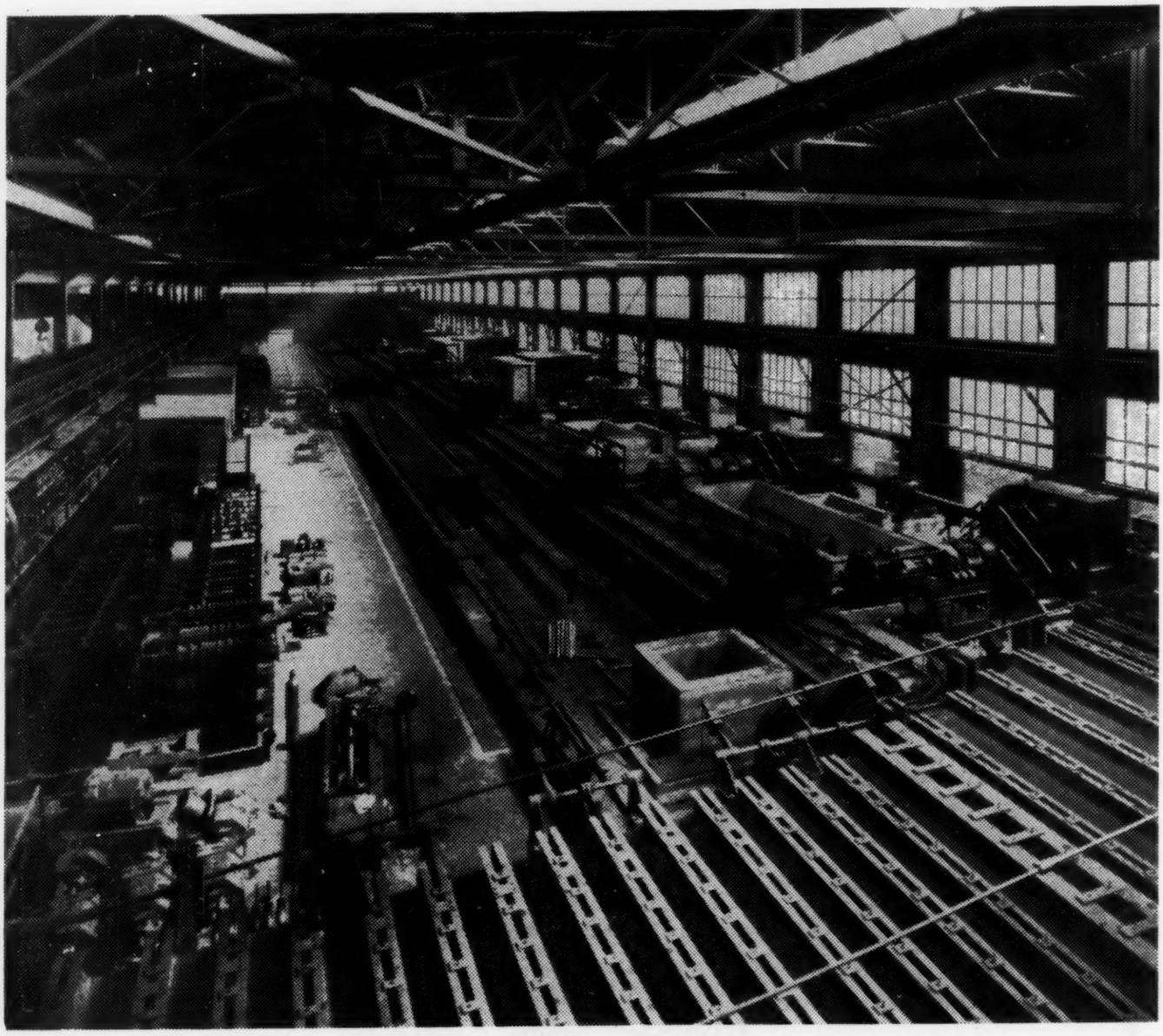

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# EDITORIALS

## THE SALESMAN, A CONSULTING SPECIALIST*

The true Salesman is patient, persistent, and sometimes long suffering. He is often classed as a pest, and must, of necessity, occasionally intrude his presence at more or less inopportune times, when he may not be as graciously received, as he deserves. He is however, "chock" full of knowledge, and experience, generally an expert in his line, and can often sight a number of cases that have come to his notice which will throw light on the single problem, we have before us at the time, which will be of great assistance in saving us from, or getting us out, of trouble.

He is often a Missionary preaching a gospel of new methods and equipment, with which we should become familiar, and if his work is along our line, it is an even break that he will know more about his detail part of the subject than we do. When we consider the number of manufacturers who are working unremittingly to improve all the detail parts of the electric equipment; transformers, motors, controller, safety switches, etc., and then realize that these firms, in their salesman, carry a highly trained force, kept constantly up-to-date, always at our command when needed we should be glad to welcome the conscientious vendor, possibly of things we do not want at the time, even if his zeal leads him to enlarge on the excellence of his make of electric stove in August, or a refrigerator in December. He can at least tell us the latest story and he must listen and laugh if we have an old one we want to work off on someone.

Many of us are prone to say that we do not have any time to talk to salesmen, but this is largely an excuse rather than a reason, and a man's reason and excuse are rarely the same. The average live-wire commercial representation has no desire to waste his time, and a short face to face talk on any article or piece of equipment, whether it be a new insulator or a turbo generator, with a man who knows his story will give us more information than many magazine articles, and we will all find time to read our current engineering periodicals. I have seldom met a salesman from whom I could not learn something.

The salesman must be able to accommodate himself psychologically, to all types of human beings and some not so human He must meet the department head who thinks his title endows him with all wisdom, as well as the one who admits his ignorance on the subject under immediate discussion but wants it all explained to him. He must make each of these men think well of himself, rather than of the salesman, for as a matter of fact, we may admire the man who is always right but we like the man best who proves, although perhaps against our better judgment, that we are always right.

There are various methods in vogue for accomplishing this purpose, but purchasers are becoming less susceptible to the old style of entertainment than formally. Not that entertainment is not legitimate, for it serves a very important role through promoting the better acquaintance, and mutual understanding, between the salesman and the purchaser, or user of the equipment, but as a primary factor in getting business we seldom encounter it today, in the larger concerns.

It is still customary with some purchasers to keep salesmen "warming a bench," as a matter of moral effect or "stage setting," thus preventing the use of his time to advantage somewhere else, as he fears to leave after sending in his card, having perhaps lost some time already. This, like all economic wastes, reflects back on all purchasers in that line, for if the manufacturer of a line of electrical supplies is to stay in business, he must make a profit, and this must be over and above sales cost, so eventually the purchaser who wastes a salesman's time pays for it at so much an hour as surely as if the salesman was on his payroll.

We of the Association of Iron & Steel Electrical Engineers, are proud of our "Salesmen" and welcome them as members, for we feel that in them we have a body of experts, than which there are no better in their line in the United States, and knowing as we do that an S. O. S. from any of us will bring replies, in the way of suggestions based on wide experience and a whole hearted desire to help, that cannot but lead to the final overcoming of our troubles.

So let us meet the Salesman as a brother of the same lodge, for his time is probably as valuable as ours and it is possible that we may become more valuable by familiarizing ourselves with what he has to sell and the extent of his knowledge of this subject. Down the line after our steel has passed over our last roller table and been handled by our last electric crane, our own pay check depends on the activity, patient persistence, and success of our own steel salesman, for whom we have no right to expect better treatment than we give to others.

*By S. S. Wales, Chief Electrical Engineer, Carnegie Steel Co., Pittsburgh, Pa.

## EDUCATION AND SAFETY

All over the United States—in the smallest hamlets—in the largest cities—in the humblest smithy shops—in the largest of our industrial plants, the doctrine of safeguarding human life and property is one of the most widely discussed problems of today.

A cord that practically every one who discusses this problem touches upon is "Education" and this cord is being vibrated so often and so rapidly that there is grave danger that those who preach the doctrine of safety as well as those who are encouraged to practice the art of safety, will fail in their respective missions unless they define more clearly what they mean by this new and much abused slogan, "Education."

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# *Magnetic Control For Steel Mill Auxiliaries**

By H. H. ANGEL†

ONE of the greatest advantages of the operation of the electric motor accrues from the ease, flexibility, and accuracy with which the drive may be controlled. The electric controller furnishes the means of connecting and disconnecting the motor from its source of power and modifies the electrical conditions governing the performance of the motor. Hence good control is one of the primary factors entering into the successful operation of a motor and the machinery driven by it.

The reduction of iron ore to iron is the first metallurgical step taken in the manufacture of steel, and whether the ore is delivered by rail or water, the ore bridge and ore unloader are important factors in handling the raw material.

The motors and machinery used for operating the trolley and hoist motions of an ore bridge are located on the trolley and are under the control of the operator who rides in the cab attached to the trolley. Usually the bridge controllers are located on one end of the bridge, it being advisable not to operate the bridging motion while any of the machinery on the trolley is being operated. When ore is being taken out of a ship and deposited on the stock piles or taken from the latter to the transfer cars, frequent operation of the bridging motors is not necessary. The operator trolleys to the end of the bridge and operates the control for the bridge motors, which is generally of the drum type as the service on the latter is not very severe. The most important motions of such a bridge are the hoist and trolley, in which special control is involved.

The elementary diagram for a single motor hoist is shown in Fig. 1. In order to properly handle the operation of the hoisting mechanism, the control must be designed to take up slack cable without undue jerk, to close the bucket at the proper speed, to accelerate the motor at a safe rate, to lower the bucket at the maximum permissible speed, and then to open the latter and deposit the ore where necessary. The control establishes the usual connection for power in closing and hoisting by the closing of 1 P contactor and the accelerating switches. 1 R being spring closed and opened only when the bucket is being opened. The accelerating contactors with series relays in the main circuit are under the control of a multi-speed master.

During the dynamic lowering, contactors 1F, 1D, 2D, 1R, 2R, 3R, 4R, 5R and 6R are closed on the first point, giving a low speed. Upon moving the master controller to the full speed lowering position, field contactors 5R, 4R, 3R, and 2R are opened in sequence, giving a high lowering speed, because the field is weakened and the weight of the bucket and ore produces an overhauling load. The weakening of the field circuit produces a comparatively high resistance in the dynamic braking circuit.

Upon moving the master controller to retard the lowering speed, the field contactors close in the same sequence, the series relays limiting the rate at which they close, thus decreasing the resistance in the dynamic circuit until only R20-R21 step of resistance is in the circuit in the off position when spring closed contactor 3D is closed and the motor comes quickly to rest. If the controller is quickly moved to the off position automatic deceleration prevents a heavy flow of dynamic braking current due to the action of a relay which is connected across the resistance, preventing 3D contactor from closing until the motor has been brought to rest through the gradual short circuiting of the above resistance. In the off position of the controller the air supply to the air operated brakes is cut off and the latter are applied. Upon failure of power when the load is being lowered the spring closed contactor 3D functions and retards the speed of the bucket to a safe

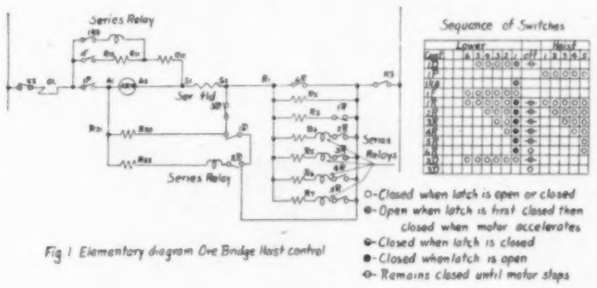



Fig 1 Elementary diagram Ore Bridge Hoist control

**FIG. 1.**

value, and by moving the controller to the off position the air brakes stop the load.

While this controller has all features necessary for operating the bucket, relatively low kick-off torque would be provided for opening the bucket if other features were not incorporated, especially if the controller was thrown to the last point, which is generally the case in most steel mill operations. A grip lever is provided on the controller handle and when it is necessary to open the bucket, the former is pressed, allowing the handle to move the controller cylinder but one point. The above lever also opens an air valve which releases a clutch and sets the brake on the opening cables, and in addition closes two auxiliary electrical contacts located below the handle and thus automatically provides more kick off torque.

Contractor KO closes and short circuits part of the resistance in series with the field and armature while 1D opens and increases the resistance in the armature circuit. The latter action results in the division of current between the series field and armature being made nearly equal and the motor starts to accelerate. The series current limit relay in the circuit of 2D contactor then releases, allowing 1D to close, giving the armature a higher voltage for higher speeds. Further acceleration allows the relay in contactor 1KO circuit to release and make contact to open normally closed contactor 1R which weakens the field and produces more speed. When the bucket is fully opened the latch is released and the bucket may be lowered in the normal way.

*Presented before Philadelphia Section A.I.&S.E.E., March 6, 1926.

†Electrical Dept., Bethlehem Steel Co., Sparrow's Point, Maryland.

Figure 2 shows the elementary diagram of the trolley control on the same bridge. This controller will give power and dynamic braking in both directions. For one direction of travel contactors P1, P2, F1, F2, F3, F4 and M are closed, allowing each motor to have its series field and armature in series. Speed control is obtained by the accelerating contactors 2R, 3R, 4R and 5R. When it is necessary to stop the trolley, the above contactors drop out and contactors D1, D2, B1, B2, B3 and B4 are closed.

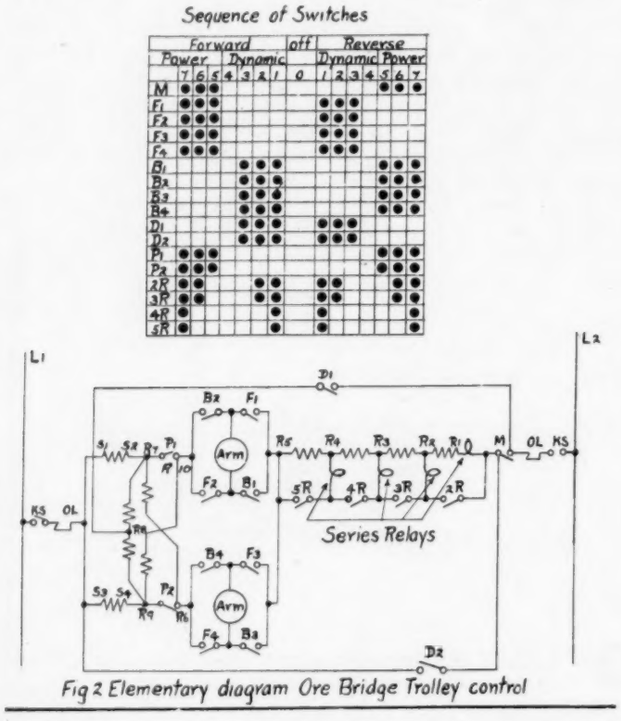



FIG. 2.

Contactors P1, and P2 which previously connected the armature and field of the same motor in series are now open and a cross connection between the armature of one motor and the field of another is established through resistors R6-R7 and R9-R10. The latter connections are necessary in order to have the load divided equally during dynamic braking. During the power operation the characteristics of series motors are such as to divide the load equally for in case one motor should attempt to take more load than the other, it will slow down and the other motor will increase in speed and equalize the load. During dynamic braking, however, just the opposite takes place, and in the event of one of the motors taking a greater part of the load, it will slow down, increasing the unbalancing still more and cause locking of the driven wheels.

Contactor D1 is used for energizing the series field from the line during dynamic braking. This is to insure quick building up of the counter voltage for if self-excitation only were used, the voltage would build up very gradually. Contactor D2 establishes a dynamic connection in conjunction with the reversing contactors, it being necessary to reverse the armature connection contactors from power to dynamic in order to obtain proper relation between armature and series field.

As the speed decreases the accelerating contactors close, thus slowing down the trolley until the air brakes have been applied.

On some ore bridge trolley controls, straight plugging with emergency air brakes and others with air brakes only are used in bringing the trolley to a stop. In the retardation of the trolley by the dynamic braking method, there are a number of things which may happen to prevent the former action but the operator has more accurate control of the trolley and it is somewhat easier to stop where desired with this method than with straight plugging as the negative torque which retards the trolley will also reverse it if the operator does not cut off the power soon enough. There is no doubt that plugging control is simpler from the standpoint of maintenance, number of contactors, and number of items failing to function, but the dynamic braking control seems prevalent.

Most of the control generally used around the coke ovens and blast furnaces consists of standard equipment, drum and face plate controllers predominating for D.C. motors, while hand compensators are used for A.C. motors. However, a few special control equipments are used, such as for transfer cars and skip hoists.

Figure 3 shows the connection of a controller operating ore and coke transfer cars. These cars are operated by four motors, two sets of two in series being connected in parallel. The single and double throw cut out switches arrange the operation with but one set of motors if one of the motors in the other set fails. One of the valuable features of this controller is the use of double pole contactors instead of single pole, thereby cutting down the possible causes of trouble and giving assurance that the important circuit changes in each motor will occur at precisely the same time. Each motor is provided

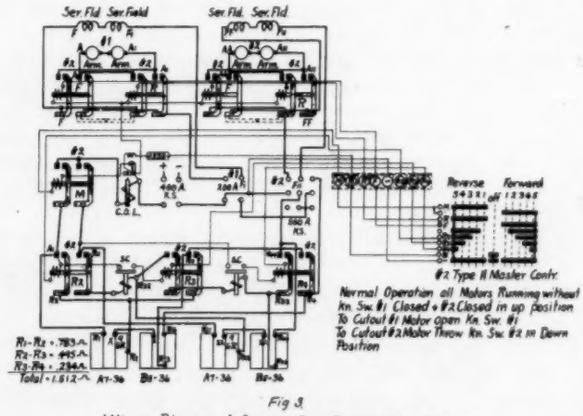

Ser. Fld.
Arm
Reverse
Forward
#2 Type H Master Contr.
Normal Operation all Motors Running without Kn. Sw. #1 Closed • #2 Closed in up position
To Cutout #1 Motor open Kn. Sw. #1
To Cutout #2 Motor Throw Kn. Sw. #2 in Down Position

Fig 3.
Wiring Diagram of Ore and Coke Transfer Car Controller.

FIG. 3.

with separate accelerating resistors which eliminate the possibility of heavy circulating currents during plugging. The latter should be resorted to only as an emergency measure as substantial air brakes are used but nevertheless some operators often stop the car by plugging in spite of all instructions they may have received.

Figure 4 is the elementary diagram of a special skip hoist controller on a blast furnace. The motor on the application is 200 H.P., 550 volt A.C., 3 phase

25 cycle having a two speed primary winding and special squirrel cage rotor winding. During starting all the accelerating resistance is in series with the low and high speed windings and during acceleration contactors 1, 2 and 3 cut out the high speed primary winding and the resistance in order to give the full speed corresponding to the low speed winding. During transition from low speed to high speed the resistance and high speed winding are momentarily inserted in the circuit and then the slow speed winding and accelerating resistance are cut out to give the full speed corresponding to the high speed winding. The contactors used in this installation are D.C. contactors, interlocked so as to open in the event of failure of the A C. source of power. The limit switch used is highly special and allows gradual acceleration and deceleration. One important feature of this controller is the protection from single phase and the unbalancing of any of the phases.

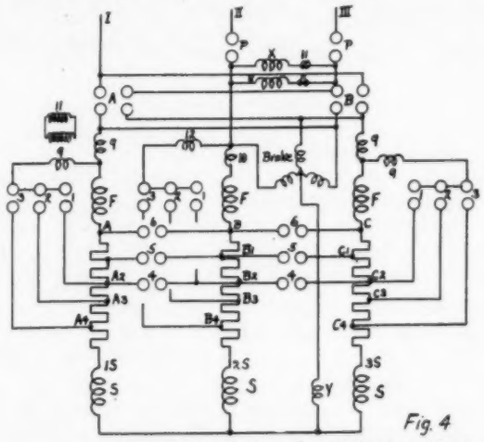


Fig. 4

Furnace Hoist Controller for Bethlehem Steel

A+B - Rev. Switch F.H. type
P - Pot " " "
4-5-6 - Fast Speed Switch F.H. type
10 - Aux. Accel. Switch - 2S Type
12 - " Stop " " "
X - Interlock " " "
1-2-3 - Slow Speed Switch - 3 SA Type
7 - Aux. Fast + Slow Sp. Sw. - IV type
K - Aux. Overload Sw. - FH. Overload type
Y - Single PH. Protection " " "
9 - Current Trans.
11 - Time Limit Overload
S - Slow Speed Motor Windings
F - Fast " " "
8 - Aux. Slow Down Sw. - 2S type

FIG. 4.

The single phase relay "Y" as connected up, functions upon the single phasing of the primary low and high speed windings, the accelerating resistors, the three phase Y connected brake, and any unbalancing caused by the failure of any of the three poles of the three pole accelerating contactors to make contact.

Electrically operated furnace bells are now being successfully operated through the use of special machinery and control. For detailed information on the blast furnace top, the writer refers anyone to Mr. Frank Cramer's paper on the "Automatic Blast Furnace," published in the June, 1925, issue of the Iron and Steel Engineer.

The open hearth does not require controllers to be of special nature, but since hot metal is handled, control must be designed in conjunction with two motor operations so that the complete failure of two units is improbable. The hot metal mixer, the ladle crane and tilting furnace operation form the most important units in successful electrical operation.

The hot metal mixer generally driven by two 75 H.P. series motors, is controlled by two independent switchboards, which are operated by two multi-speed master controllers usually latched together. An electrical failure while the mixer is pouring metal into a ladle is very serious, and may result in a large quantity of metal running out of the spout into the scales and ladle transfer car located beneath. Separate power lines are run to the Power House so that no electrical disturbance elsewhere in the open

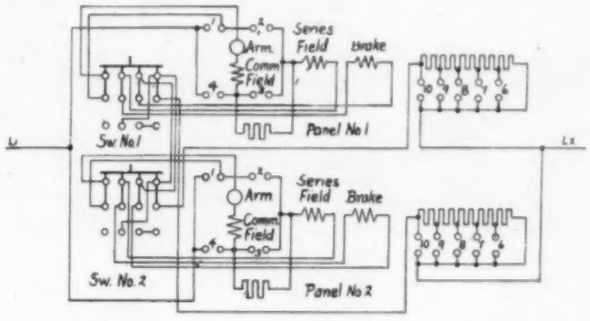



Fig. 5. Elementary diagram of Main Hoist 175 ton Ladle Crane

FIG. 5.

hearth will affect the source of power to the mixer. In some plants provisions are made for the emergency operation of standby storage batteries in the event of power failure. If one motor should fail, or if control on the switchboard and master controller should fail, the motor and control circuits would be cut out by the opening of the overload relays and control fuses, thus allowing one motor to continue the operation of the mixer. Limit switches are used in cutting out the raising and lowering motions on the mixer and are very important if the operator for any reasons allows the mixer to overtravel either through carelessness or from a fire caused by the splashing of hot metal in which he is forced to leave his controllers which are generally located very close to the mixer. The failure of the motors to be cut out after the mixer has reached its limit of safe travel would do considerable damage to the mixer itself, and even if the limit switch cuts out in the lowering direction, metal will be spilled on the scales. To prevent the latter occurrence, one of the electrical manufacturing companies furnishes a so-called "dead man's master" controller in which the operator must always keep his hand on the master

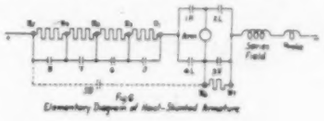


FIG. 6.

controller. Should the former take his hand off the controller, the spring return would bring the mixer to the up position until the limit switch cuts it out

The writer has found that mixer limit switches, more than those used for any other service must be extremely reliable, not merely from the standpoint of cutting out the circuit, but also in re-establishing it after the mixer has traveled far enough in the reverse direction to allow the former to again make contact. Not many months ago the operator hand-

ling a 1300 ton mixer was unable to bring it back again after emptying a certain amount of metal into a ladle. The mixer "up" limit switch cut out the control when the mixer had been raised previous to pouring. The loss of metal, while small in this case, would have been much heavier if the electricians had not been nearby at the time and closed the "up" reversing contactors by hand. The limit switch opened the control circuits independently, being designed to prevent both controls from being out of commission, if there was an open circuit in one of the limit switch contact fingers. The electrical features of the above

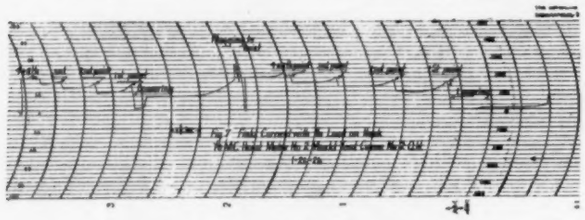


FIG. 7.

were very good, but it was found that the spring which returned the limit switch cylinder to the off position was weak. The spring was made much heavier and as an additional precaution, normally open push buttons were installed near the operator so in the event of a recurrence he could short circuit the limit switch while attempting to raise the mixer.

Figure 5 shows the elementary diagram for the control of the main hoist of a 175 ton ladle crane.

The latter is operated by two motors arranged so that either one may be cut out while the other operates the hoist for short periods of time until repairs can be made, the motor carrying the load being somewhat overloaded. Two separate controllers are furnished and the double throw switches shown are used in connecting the solenoid brakes in series with the motor handling the hoist. One master controller is used in operating the two boards. Some engineers prefer two master controllers or one with separate contacts for each controller, but the writer feels that, although the above may sometimes prevent a "heat hanging," the additional expense and maintenance

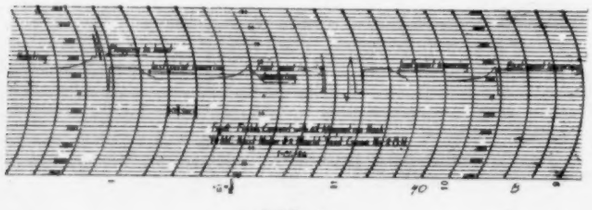


FIG. 8.

involved is hardly warranted, as molten metal remaining in a ladle a few minutes longer is affected but little.

The hoist of this crane is of the straight control type employing shunted armature on lowering, load brakes being used to prevent the load from overhauling the motors. This control is very simple, is easy to "shoot trouble," and the reversing contactors can be closed by one electrician for short periods of time if the control is in trouble and a full ladle is on the crane. A large number of cranes do not use load brakes, dynamic braking being employed.

The latter is very satisfactory in operation, is reliable and reduces maintenance considerably on the solenoid brakes and eliminates any maintenance which otherwise would be necessary to load brakes. Of course, it is very much more complicated than straight control, it is harder to "shoot trouble," and is much more difficult for proper inspection, but a considerable amount of its ruggedness is dependent upon the simplicity of the power circuits and the number of relays and electrical interlocks used. It has been found that dynamic braking control is much more satisfactory for the auxiliary hoists of ladle cranes operating on the pit sides of the open hearths than straight control as no load brakes are employed

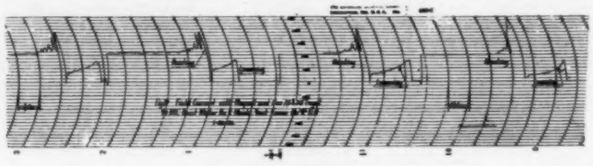


FIG. 9.

and the lowering speed when handling heavy slag ladles which may be beyond the capacity of the hoist becomes excessive. In order to lessen the time required for lowering the empty hoist, one of the electrical manufacturing companies uses a special relay and contactor which allows high speed when lowering the empty hook.

The bridge motion of a ladle crane is equipped with control similar to that for a main hoist, allowing one motor to be out of service and giving continuity of service. The control for the tilting motor of the furnaces is practically a duplicate of the hot metal mixer control, except that generally four motors are employed instead of two.

Figure 6 shows the elementary diagram applying to the hoist of a 15 ton mould yard crane.

As can readily be seen the motor operates as a series one hoisting and lowering, the armature being shunted on lowering to prevent over-speeding. Probably 80 per cent of the crane hoists in our plant are so equipped, and very satisfactory results are being obtained. The cranes so equipped very rarely handle loads up to the rated maximum capacity and

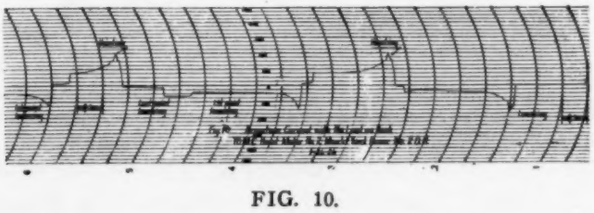


FIG. 10.

so long as the armature shunting resistance is in good condition, the lowering speed is limited.

A number of curves were taken from the above crane with various loads as indicated. In addition to the armature and field currents, speed readings were observed with a tachometer. In Fig. 7 with no load on the hook the field current variation is distinctly shown point by point, because the armature shunt resistance which produces the strong field is in series with the armature accelerating resistance. The field current at maximum lowering speed is about 175 amps. On Figure 8 the field current is

only 130 amps. with the 62" (8900 lbs.) magnet on the hook. Although the armature shunt (slow down) resistance is the same, the field current is less due to the increased lowering speed. On Figure 8 the field current is further reduced, due to the greater speed with the magnet and 25x30 ingot (12,500 lbs.) a total of 21,400 lbs., and is about fifty amps. On each of the above curves the armature lowering speeds were 500, 600 and 1450 RPM, respectively, and it can be seen that the plugging

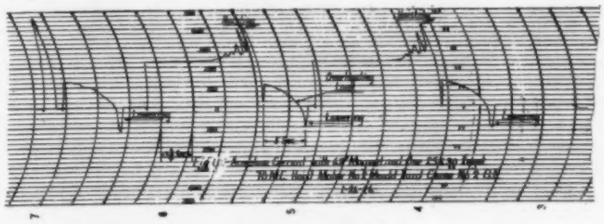


FIG. 11.

peaks upon stopping were correspondingly increased. For instance, in Figure 9 the peaks vary somewhat, depending upon the speed reached when the controller was shut off, and operated in the reverse direction immediately. During the plugging periods the magnetic time relays were adjusted so that no accelerating contactors could close until the negative torque on the hoist would stop it and start to turn it in the opposite direction. During the test shown on Figure 9, the first accelerator was allowed to close at the same time the hoist contactor closed in order to plug the motor and the meter needle was deflected off the scale. This shows how important it is to use enough resistance to limit the plugging peak to a safe value.

Figures 9, 10, 11 and 12 show the armature currents hoisting and lowering various loads. In Figure 10, where the empty block is lowered the armature current is only 50 amperes. In Figure 11, with the magnet and ingot, a total of 21,500 lbs., the lowering speed is very high and a very short time after the load has started to lower, the armature current reverses and forces current back into the line. Upon plugging the current reaches over 400 amps. Figure 12 shows a load of one magnet and two 25x30 ingots, a total load of 34,000 lbs. being lowered. As the time required for lowering the same distance with

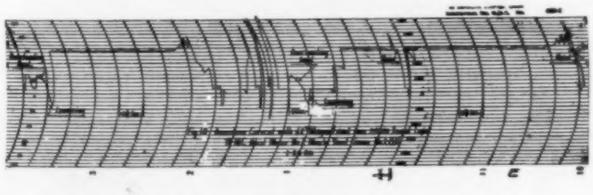


FIG. 12.

this load is about little more than half that required for the 21,500 lb. load, the armature reverse current reaches its maximum in a correspondingly short time. Due to the limited amount of travel with this hoist it is not known how high the armature reverse current in Figure 12 would have been if the load could have been lowered a greater distance. The armature plugging current in Figure 12 is extremely high, it being about 150 per cent of the current normally taken by the 70-MC (87 H.P.) hoist motor.

Figure 13 shows a tabulation of the speeds, armature and field current taken during the above tests. The second column indicates a special contactor "SD" as shown in Figure 5 used on this test. Several maintenance men have claimed that an operator may lower a heavy load on the first point faster than on the last point, in order to hurry along the particular job, due to the armature resistance being in series with the slowdown resistance. By using contactor "SD," whose operating coil is connected in parallel with the coils of the lowering contactors, the series field will be strengthened at all times on lowering, but the speed test failed to indicate any appreciable advantage. It has been found that for soaking pit crane service when handling unusually heavy ingots a noticeable difference of speed is noted, but it is felt for practically all applications the use of the extra contactor would entail extra first cost, extra space, additional maintenance and possibly more trouble. The third column showing the dangerous lowering speed with no slowdown resistance indicates the importance of good slowdown resistance, which must not be composed of light and breakable grids, but of heavy grids which will be unaffected by vibration.

The above tests show that by using proper acceleration and slowdown resistance a simple control

Armature Speed and Motor Currents

| Operation | Slow down Resistance Connected the Normal Way | Contactor Used with Slow down Resistance | No Slow down Resistance Used | Armature Current | Field Current |
|---|---|---|---|---|---|
| Lowering 1st point - No load | 730 RPM | 400 RPM | | | |
| Lowering last point - No load | 500 " | 500 " | 930 RPM | 40 | 175 |
| Hoisting last point - No load | 900 " | 670 " | | 75 | |
| Lowering 1st point - 62" Magnet | 480 " | | | | |
| Lowering last point - 62" Magnet | 600 " | 650 " | | | |
| Hoisting 62" Magnet | 600 " | | | 185 | 130 |
| Lowering 1st point - 62" Magnet and One 25"X30" Ingot | 1400 " | 1450 " | | | |
| Lowering last point - 62" Magnet and One 25"X30" Ingot | 1450 " | 1400 " | 2200 " | 200 to 225 Reverse | 50 |
| Hoisting 62" Magnet and One 25"X30" Ingot | 470 " | | | 225 | |
| Lowering last point 62" Magnet and Two 25"X30" Ingot | | | | 240 to 250 Reverse | |
| Hoisting last point 62" Magnet and Two 25"X30" Ingot | | | | 290 | |

Fig 13.

70 MC Hoist No 2 Mould Yard Crane No 2 O.H.

FIG. 13.

can be used which will handle light and fairly good loads successfully and very heavy loads occasionally where great care is taken. Where the latter loads are handled frequently Figures 12 and 13 show that straight control is not the proper control and dynamic braking control should be employed. For instance, when the magnet handled one 25x30 ingot, the solenoid brake allowed about a three foot drift when the current was cut off, while with the handling of two 25x30 ingots the drift was nearly seven feet. The writer has very seldom seen two ingots handled at one time but in this case it is shown what speed is possible with very heavy loads.

Some engineers prefer dynamic braking control on practically all crane hoists. In our plant a number of installations of dynamic braking control has been replaced by straight control, due to its simplicity, ease in locating trouble and placing the hoist in operation again in the shortest possible time. On some applications much faster operation is obtained by straight control, as the full lowering speed is reached in a shorter time due to the difference in speed characteristics between the series motor for straight control and the shunt motor for dynamic braking. The use of dynamic braking control also requires the crane operator to leave the controller

on the first point for a few seconds in order to allow the solenoid brake to release with full field current. This has often caused brake trouble and has lead to replacement by straight control in a few instances. It is very true that the wear on the brakes is greater with straight control but the tendency is always to plug, thus taking the burden off the brake shoes. The latter practice is safe if the control will not allow more than say 150 per cent plugging peak.

Hoist control with shunted armature for lowering has been applied to the stripper and soaking pit cranes with good results. The writer is of the

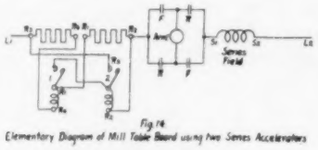


Fig 14.
Elementary Diagram of Mill Table Board using two Series Accelerators

FIG. 14.

opinion that better hoist operation is obtained with dynamic braking control in this application, but other factors enter into important consideration. Stripper crane service is not as severe as soaking pit crane operation, and any delays due to control trouble would not be so serious in comparison with soaking pit cranes.

In a mill operating at full capacity, soaking pit cranes are usually busy at all times, placing the ingots in the soaking pits, relocating ingots which are in the pits, and removing same to the ingot buggy which carries the ingot to the mill approach table.

Due to the increased complication of dynamic control more electrical calls result. If the electrician is thoroughly experienced with this type of control, the trouble might be located in a very short time However, it is not possible to make all the electricians handle these calls proficiently. In our plant the soaking pit cranes all have straight control, and in handling heavy ingots the operators know by experience when to shut off the controller and allow the brake to slowly stop the ram when ingots are being lowered into the pits. Very often when the ingots are being placed in the ingot buggy the operator is so skillful in handling the crane that no time is allowed between shutting off the power and dropping the ingot. When the ingot is within a

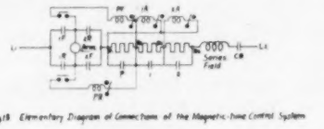


Fig 15 Elementary Diagram of Connections of the Magnetic-time Control System

FIG. 15.

certain distance of the ingot buggy the operator quickly reverses his controller, at the same time operating the grip mechanism which releases the ingot. The plugging relays are so adjusted to prevent any of the accelerating resistance from being cut out until the ram has stopped. It is the best policy to keep the best operators on the job, as it is well known that poor operators will do more damage to the mechanical equipment on the crane than to the electrical.

Figure 14 represents the elementary diagram of a mill table controller using one series plugging contactor and one series accelerating contactor. The series contactors perform very favorably when the loads are very uniform, but when the table is started after a shut down, or when the former is improperly lubricated or in poor mechanical condition, their operation is not so good. The trouble is inherent

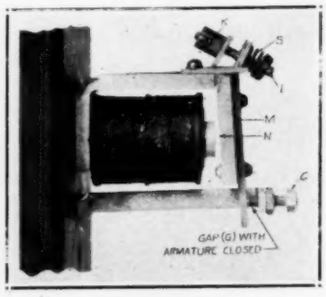



FIG. 16.

with practically all series contactors and not with the product of any one manufacturer. When the table is not accelerating or decelerating quickly enough, due to any one of the above conditions, the accelerators are set to function at a higher current value. This results in very fast operation when the table is again in normal condition. When power is cut off a table and then put back again while the table is drifting in the same direction, the current passing through the series coils is not heavy enough to close the contactor with the result that the table slows down when steel passes over it. On many applications, however, it is felt that a combination of time and current limit acceleration is the proper thing to use even though the controllers be equipped with small relays and interlocks, the latter being noticeably absent from series contactor control.

Figure 15 represents the elementary diagram of a controller placed in operation during the early part of 1925, utilizing a combination of definite time for

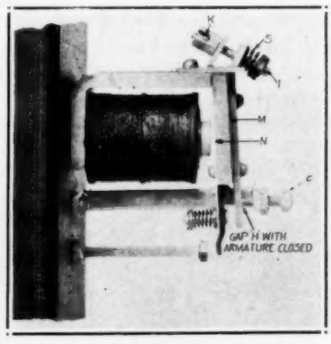



FIG. 17.

acceleration and counter EMF for plugging. Figures 16 and 17 show the mechanical construction of the relays used, Figure 16 being for the normally closed and Figure 17 for the normally open. The armature "M" is held firmly in place by having its upper knife edge resting against the plate by means of the spring "S."

The cap screw is used in limiting the amount of travel of the armature and is adjusted so that the latter moves about 1/16 of an inch in the case of the normally closed relay and about 5/16 of an inch in the normally open relay. The gap in the normally

closed relay should not be changed as adjustments are taken care of by the spring "S" and the bronze shim "N" attached to the armature "M," between the latter and the pole pieces. The adjustment of the normally open relay is taken care of by the spring "S" and the gap "H."

When an energized coil in a magnetic circuit is short circuited, the flux in the magnetic circuit dies out slowly. The general characteristics of the falling off in the flux plotted against the time are shown in Figure 18. A certain pressure PI on the armature will release at time TI. By decreasing the pressure P2, the value of the flux at which the armature will release changes from PI to P2 while the lapse of time increases from TI to T2. By having the iron oversaturated when the armature is closed the time adjustment can be made independent of the variation of line voltage.

The calibration range obtainable by increasing or decreasing the tension applied by spring "S" on the normally closed relay is shown on Figure 19. A definite time calibration ranging from .4 to .8 seconds may be obtained by use of a 10 mil bronze shim "N" in the air gap. In Figure 19, zero number of turns is taken as that tension which will just pull the armature back into position against the top plate

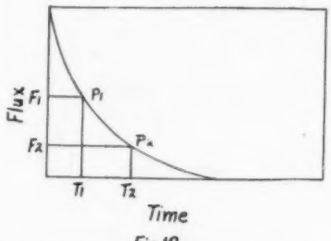



Fig. 18.

FIG. 18.

when the former is pulled down slightly by hand. The other curves show the result of using other size shims. When quick drop out times are necessary, the use of heavier shims is resorted to in preference to very heavy spring pressures since the latter may be increased to a value which will prevent the armature from closing when the voltage drop across the resistor is applied to the coil. Figure 20 shows the application of the relay when the motor is started from rest in the forward direction. At the instant contactors 1F and 2F close, the armature circuit is established through the resistor and the voltage drops across divisions R1-R2 and R2-R3 are applied to relays 1A and 2A respectively. The latter pull in and open the contacts of these relays, at the same time the electrical interlocks on 1F contactor has completed the circuit to relay PF and the latter closes due to the sum of the voltage drop across the armature, and the resistor R1-R2 which is sufficient if the relay be properly adjusted. The closing of the normally open relay completes the circuit to contactor P, the latter short circuiting step R1-R2 causing dissipation of the flux produced in the relay frame until a density is reached such that the spring "S" exerts sufficient force to release armature "M."

The closing of the contacts of relay 1A closes contactor 1A, causing the short circuiting of resistor R2-R3 and the consequent releasing of the armature of the relay in a definite time and energizes the coil of contactor 2A. In connection with this, when the closing of the forward contactor closes relays 1A and 2A, the latter do not break any circuit to the respective contactors as the circuit must first be closed through the normally open relay PF. The latter closes immediately upon starting from rest, but the interval of time lost between the closing of the main contacts on IF and the relay PF allows the former relays to close without any arcing. However, the writer has found arcing on relay tips, when there

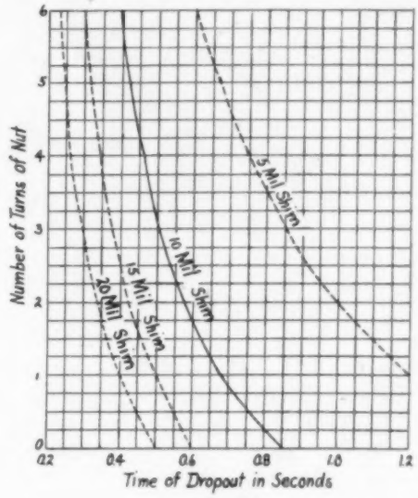



Fig. 19

FIG. 19.

was too much air gap and spring pressure. It was the case of the operator desiring more speed than that which the controller when first installed allowed, and the relays were improperly adjusted.

If the motor after attaining full speed is now stopped and started from rest in the reverse direction, the same conditions exist as before except that the interlock on contactor IR controls relay PR.

Figure 21 represents the conditions existing if the motor after, having attained full speed in the forward direction, is quickly plugged. The counter electro-motive force of the armature is applied in the opposite direction and hence at the instant of plugging the voltage across the coil of relay PR is

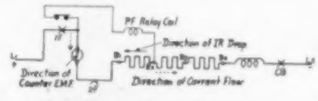



Fig. 20—Current and Voltage Conditions in the Controller When Motor is Started From Rest

FIG. 20.

practically zero and the relay remains open. During deceleration, the motor acts as a generator and the counter E.M.F. is opposite in effect to the voltage drop across R1-R2. The C.E.M.F. falls off to zero as the motor comes to rest while the voltage across R1-R2 decreases from the maximum shown at the instant of plugging during which from 125 per cent to 200 per cent of the starting current was flowing, to a value similar to that at starting from rset. The relay PR will therefore pick up as the motor comes to rest and will energize the plugging contactor "P" and the acceleration is the same as previously described.

The plugging relays should pick up on the voltage drop across the plugging resistor R1-R2 when the motor is started from rest, but must not be adjusted with too small a spring pressure since on plugging the relays will close too quickly and close the plugging contactor while the motor is running at a considerable speed. The closing of the latter contactor will short circuit the resistor R1-R2 leaving the relay coil across the armature only, bringing the armature to rest and then in the reverse direction. At the instant the armature is at rest the relay will drop out due to practically no C E.M.F. and as the motor speeds up the relay will again close.

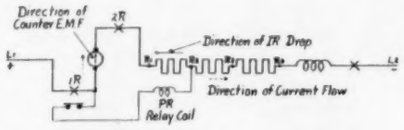



Fig 21.-Current and Voltage Conditions When Motor is Plugged

FIG. 21.

The latter action is very undesirable, the so-called "pumping" of the relay causing severe torques.

If it is necessary to close the plugging contactor before the armature is brought to rest by the torque produced from the current flowing through the total resistance, it is necessary to connect the coil so as to include R2-R3 resistor, which means that when the plugging contactor has short circuited resistor R1-R2 and the counter EMF is zero, the drop across R2-R3 is sufficient to hold the relay closed. The writer has found the latter necessary on the trolley and bridge drives on some cranes where the deceleration was slow and it was advisable to employ the above scheme rather than decrease the total resistance, which allowed more plugging current with a higher mechanical jolt than with the other method. Figure 22 shows a curve taken on a 19 roller mill table using the above methods of control. (The plugging current is much lower than indicated as the meter used was undamped.)

When calibrated against a damped millivoltmeter it was found the peaks were from 75 to 150 amps. less than shown. The mechanical maintenance on

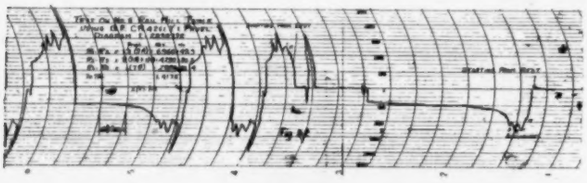


FIG. 22.

the mill table was reduced to about one-third of the previous figure after this board was placed in operation.

Figures 23 and 24 show the so-called voltage drop relay which controls the operation of the contactors in Figure 25. Each relay consists of two coils with independent and adjustable magnetic circuits, the magnet frames being "D and E," the pole pieces "C and F," and the respective armatures "A and B." The armature can be attracted by either or both coils and the travel is limited in both directions by stops which are also used as contact points, thus making it possible to close a circuit either in the off position or when the armature is attracted.

Ordinarily the normally closed contacts are used, and when the relay is called upon to function the former is closed, due to the coils receiving a potential either from the voltage drop across the resistance or from the control circuits, and is called upon to open the control circuits of the accelerating contactors. The time required for the relay to drop out depends upon the air gap between the pole pieces F and C and armatures A and B, respectively. For quick dropout and consequent fast acceleration it is necessary to have a large air gap as the relay will function at that armature current, or voltage drop across the resistor which the relay is adjusted for.

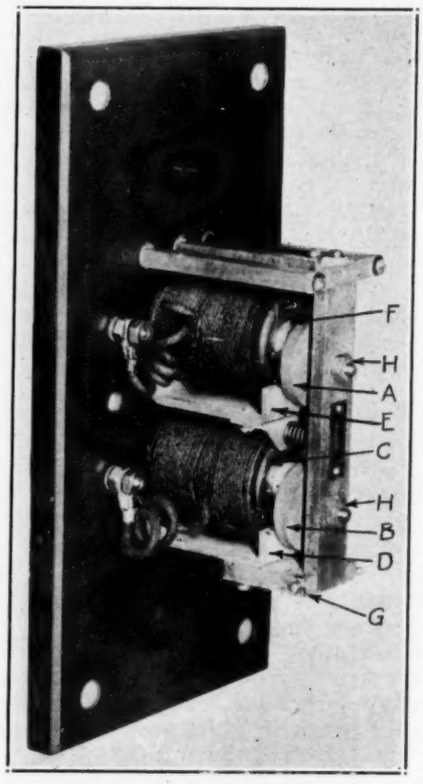



FIG. 23.

Care must be taken not to have the armatures A and B in mechanical contact with the magnet frames D and E or coils C and F when the relay is picked up. The above action results in iron to iron contact with the probability that the relay will have its adjustment changed and possibly stick.

The diagram in Figure 25 shows the controller using three shunt accelerators and four voltage drop relays operating a 40" Blooming Mill screwdown. When the line switch is closed with the master controller in the off position the upper and lower coils of the "Raise" and "Lower" relays are connected in series across line voltage. Both relays immediately pick up opening the right hand contacts. If the master switch is then moved to the "Lower" position the two "Lower" contactors close and complete a circuit for the motor armature and field through the starting resistor. The left hand "Lower" contactor short circuits the lower coil on the "Lower"

relays while the upper coil is energized equal to the voltage drop across R1-R2 of the resistor. The lower coil of the "Raise" relay is energized by full lune potential and therefore remains closed keeping the contacts open. As the motor accelerates and the voltage drop across R1-R2 decreases, the "Lower" relay drops out at a predetermined value and thus energizes the first accelerating contactor.

On the relay marked "6" the lower coil is connected across R1-R2 and the upper coil across R2-R3. When the "Raise" contactors close the relay picks up, due to the voltage drop through the starting resistors. When the first accelerating contactor closes, the latter short circuits the lower coil and as the motor accelerates the relay drops out when the drop across the resistor R2-R3 reaches a predetermined value. This relay in dropping out energizes the second accelerating contactor. In the same way

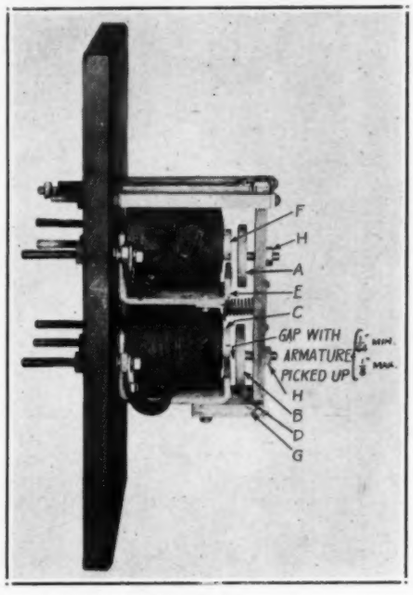



FIG. 24

the relay marked "7" functions as the closing of contactor "2" short circuits the lower relay coil and allows the upper coil which is across R3-R4 resistor to function at the desired voltage drop. The lower coils do not enter into the actual calibration except in providing a small time delay. The lower air gap should be about 1/64 of an inch and when the accelerating current is very small, which would allow fast acceleration, each lower coil is short circuited and the self inductance of the short circuited coil allows a small time lag.

When the master switch is moved to the "Lower" position the reverse contactors close and the accelerating contactors close in order, with the "Lower" relay functioning in a similar manner to the "Raise" relay previously described. It should be noted that at reversal the "Lower" relay is already picked up and there is no race between the relay and the contactor to determine which will close first.

Figure 26 shows a curve taken on the screwdown which is operated by two 150 H.P. motors permanently in series. The actual plugging peaks are several hundred amperes less than are shown because the meter used was undamped. The curve shows the closing of one plugging contactor and one accelerating contactor because the second accelerating contactor had been blocked out for some time in order to introduce more permanent resistance in the circuit.

On this particular board all relay coils with the exception of the lower coils on relays "6" and "7" are 250 volt coils wound for continuous service. When first placed in operation it was found that the relays would not close when the motor started from

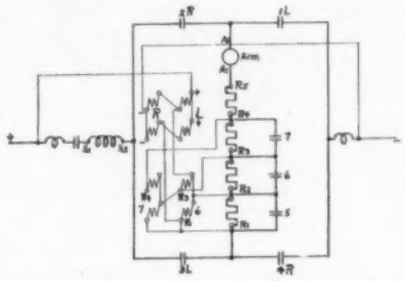


Fig 25 Elementary Diagram Screw Down Voltage Drop Relays

FIG. 25

rest because the coils were connected across blocks of the starting resistance and the voltage drop across the former was not sufficient to close the relays at all times. When the upper air gap was made smaller in order to have more flux available for picking up the armature, the acceleration was slower which gave the mill operators cause of complaint. In order to get the desired results 125 volt coils were used. This meant much more flux was available in the lower coil for pulling in the relay without affecting the calibration for, as explained above, when the relay is called upon to function the lower coil is short circuited.

This controller appears to be very complicated, but due to vertical contacts, substantial coils, and covers being provided for the relays which are mounted together, highly satisfactory results have been obtained. The relays have been very reliable in their operation and there is no likelihood of any change of adjustment being made except for the presence of dirt or some one arbitrarily changing same. When the board was first placed in operation the writer found that some mornings the time of

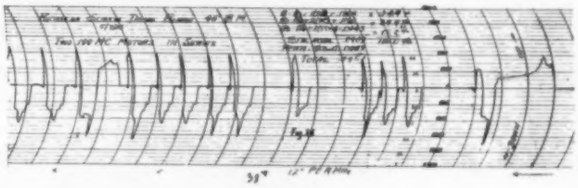


FIG. 26

acceleration was different, but on a careful check up it was found that the change of mechanical parts of the screwdown, or the lack of proper lubrication was the cause of the change in the rate of acceleration.

A controller has recently been placed on the market which is called the inductive time limit controller. The accelerating time is obtained by the inductive principle, involving a transformer having no moving parts. Figure 27 shows the diagram of controller connections.

Faraday's law of induction states that when a magnetic flux within a loop of wire varies with the time, an E.M.F. is induced in the loop, the instantaneous value of which is proportional to the rate of change of flux. If direct current is passed through the primary winding of a transformer the building up of the flux will induce an E.M.F. in the secondary winding and if the latter be closed through an external resistance, a current will flow which will be of transient nature. Even though the current continues to flow through the primary winding, the current through the secondary winding will flow only temporarily because with the current constant in the primary winding there will be no change of flux in the magnetic field. However, due to the stored energy of the magnetic field, the secondary current will not die down, instantaneously, but gradually, as the magnetic flux will oppose any change of current in the secondary winding.

The above principles are utilized in obtaining accelerating time by employing a transformer composed of a solid iron core with two windings, either one of which has the ampere capacity to carry the

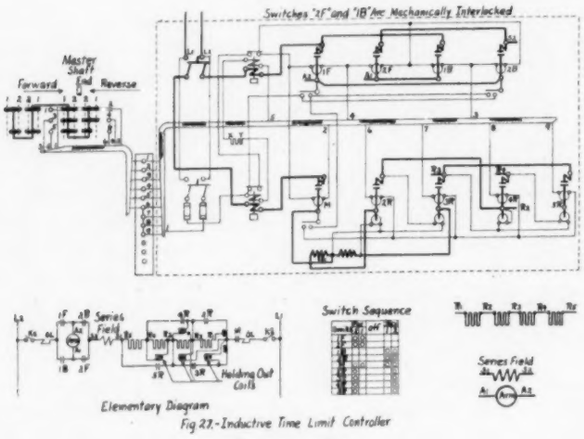



FIG. 27

armature current. The current derived from the induced E.M.F. in the secondary windings is passed through the holding out magnet "6" on the accelerating contactor shown on Fig. 28 and prevents the latter from closing when the shunt coil "5" is energized until the secondary current has decreased to a predetermined value. During acceleration the transformer primary winding is transferred to the secondary winding and vice-versa; and in this manner only two coils of the transformer are utilized for acceleration. These two windings are furthermore so connected that the direction of flux in the transformer is reversed when transferred from one winding to the other, and as the induced voltage depends upon the rate of change of flux, a considerably higher voltage is obtained in this way than would be the case if the flux were not reversed. Consequently, the induced current and accelerating time are increased accordingly. The variation in accelerating time is obtained by adjusting the magnetic gap "3" of the holding out magnet on the accelerating contactors shown on Figure 28, as this adjustment will vary the pull exerted by this magnet and consequently the latter will release the different values of secondary current.

The holding out magnet consists of a spool which is wound directly on an iron core. The latter forms part of the magnetic circuit and is bolted to the magnet structure. Through the center of this core is a brass stop for the contact lever and hence the

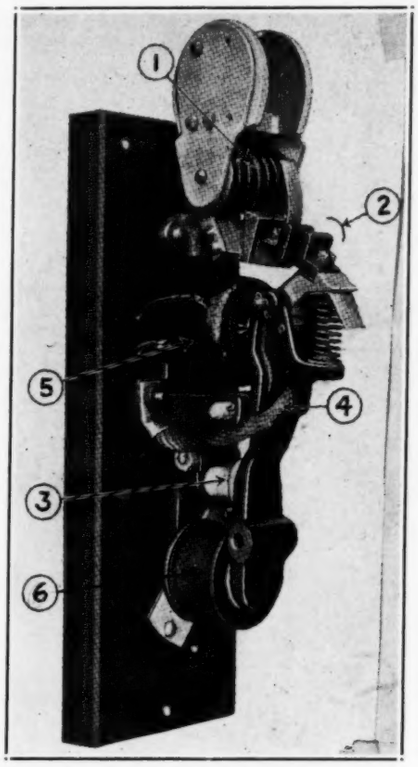



FIG. 28

only cause for mal-adjustment is the wear on the stop itself.

The adjustments for varying the air gap exists in three places. The adjusting screw "3" directly under the hinge pin, is held firmly from turning by the clamping screw and forms part of the magnetic circuit through the frame, the core on which the holding out coil is wound, and the lower half of the contact lever. By screwing same in or out, care being taken not to touch the contact lever, the rate of acceleration is increased and decreased respectively. A coarser adjustment is obtained by varying the air gap between the holding out magnet and the lever which is taken care of by shims placed between

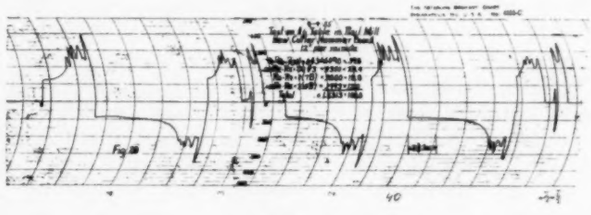


FIG. 29

the spool and magnet frames. The time of closing for each contactor can be varied between 1/10 second and one second. The adjustment which can be obtained by varying the adjusting screw is from approximately ¼ second to one second. By removing

a shim and adjusting the adjusting screw a range of 3/10 to 1/10 of a second will result.

The time of closure of the accelerating contactors depends, in addition to the stored energy of the magnetic circuit also on the induced E.M.F. in the secondary winding of the transformer which latter again depends to some extent on the value of the primary current. It is, therefore, not possible to obtain the maximum time referred to under all conditions. Starting from rest approximately a minimum of 3/10 second is required for the first accelerating contactor to close because time is required to build up the flux on the closing coil "5" and in plugging a much longer time as only part of the winding is in the circuit when the main contactors close. With

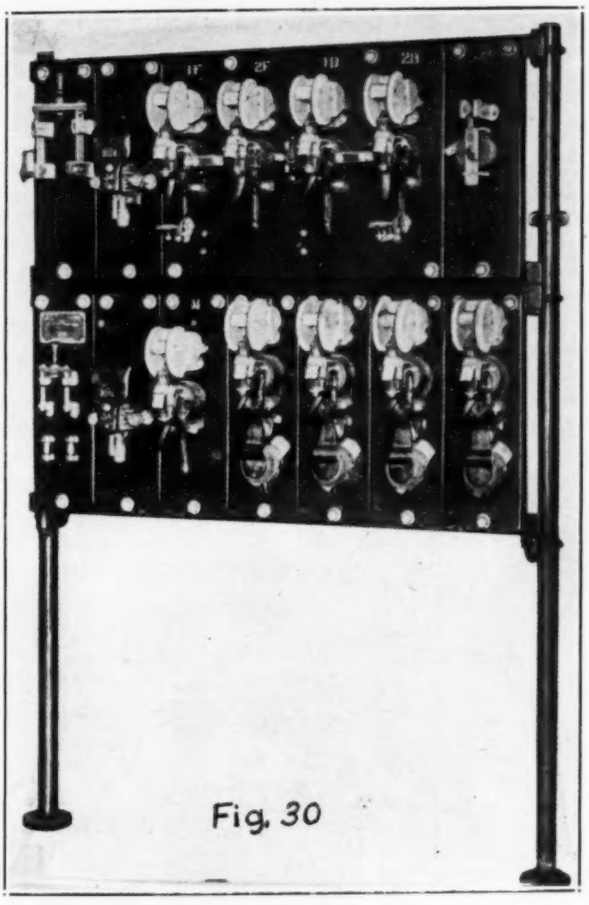


Fig. 30

this arrangement different magnetizations when starting and plugging are obtained due to the higher plugging current; that is, when starting from rest the iron is below saturation. In order to obtain uniform time in starting from rest during various load conditions it is necessary to saturate the iron in the transformer and this is possible only after the first accelerating contactor has closed. Consequently this control gives a variable time in starting and plugging with the first accelerator and constant time on the remainder. Figure 29 shows the acceleration curve obtained with the above controller operating a 19 roller mill table driven by a 60 H.P. mill motor. Figure 30 is a picture of the complete controller.

Figure 31 shows the connections of another type of controller suitable for mill tables of crane service. A dashpot relay is used and a combination of time and current limit is obtained. The dashpot relay has four contacts which are arranged so as to close at different points between the total travel of the above.

The relay coil has two windings, the one between tap "A" and "B" being for the full voltage which is used to close the relay, while the winding between "B" and "C" opposes the above winding.

The opposition winding is connected across the last step of the acceleration resistor and receives

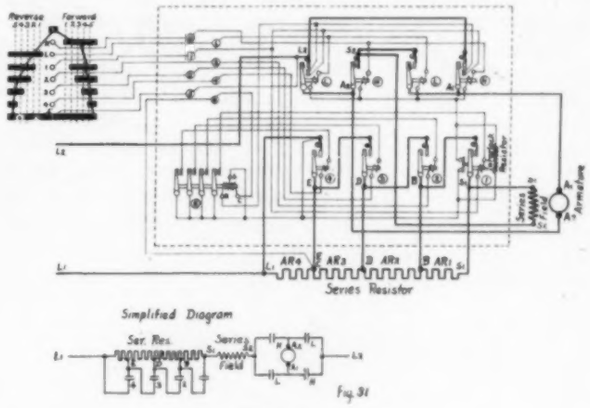



FIG. 31

flux derived from the voltage drop across the resistor.

Starting from rest the armature current is about 70 per cent full load current and the drop across the last step of resistance is sufficient to appreicably affect the flux available in starting to close the relay. The first set of contacts closes and energizes the first accelerator. When the latter closes the coil "BC" receives an additional potential due to the increased current and tends to retard the closing action. The same action is again noticeable as the remaining

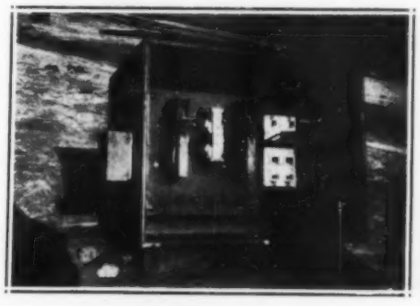


FIG. 32

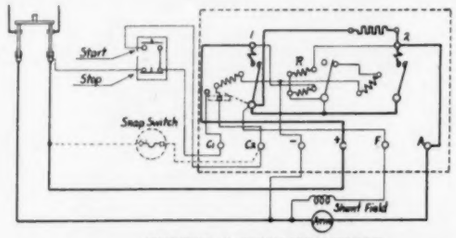
contactors cut out resistance. On plugging the armature current may reach as high as twice the starting current in which case the flux from "BC" which has now received a high voltage drop is very appreciably in opposition to that in coil "AB" resulting in the relay not starting to close until the same conditions are reached as upon starting from rest.

Numerous applications of motor drives in steel mills require special control involving complicated wiring. Where dynamic braking is required with the use of shunt or compound motors, the control connections are not as complicated as when series

motors are used. It is sometimes necessary to perform an operation which requires the use of two controllers operating two motors interlocked through limit switches.

Such an arrangement is at best very complicated, and in order to minimize trouble no expense should be spared in making main contacts, interlocks and limit switches, as rugged as possible. For instance, in a proposed application of the air and gas reversing valves of some soaking pits in a blooming mill, it is necessary for an auxiliary valve to work in conjunction with the former and in order to obtain results it was thought best to have the soaking pit heater operate the controller in the direction desired and then allow the various limit switches to cut out the reverse valve and place the auxiliary valve in operation. It can be seen a mental burden will be removed from the heater but only very rugged control will insure the success of the motor application.

There is a very large range in starters required for shunt motor applications in a steel mill. Among the various types the face plate, hand starter, cur-




OPERATION of VOLTAGE DROP STARTER

When the two pole knife switch is closed the voltage drop relay R pulls in due to the lower Coil receiving practically full line potential. When No.1 Contactor Closes the lower relay coil is short-circuited and the upper relay coil receives potential equal to the voltage drop across the starting resistor. After the voltage across the resistor decreases, due to the motor accelerating the relay drops out, thus closing the accelerating contactor 2. When the push button or snap switch is operated to stop, the line contactor 1 drops out and the relay R will not close and drop out contactor 2 until the motor has dropped to about half speed as the counter E.M.F. of the motor at time of opening contactor 1 causes the voltage across the lower coil of the relay to be too low

RELAY ADJUSTMENT

Never touch the bottom adjustment. It is set in the shop with a gap.
To accelerate the motor more quickly increase the upper gap.
To " " " " slowly decrease " " "

Fig. 33

FIG. 33

rent limit, time limit and counter E.M.F. predominate. On some applications, either of the above types will work very satisfactorily, while on others only one type may be suitable.

The standard face plate starter is used on a large number of applications of small motors and serves its purpose very well when the application does not require frequent starting of heavy loads. When used for heavy loads the maintenance and delays become high and it is usually replaced by an automatic starter.

Current limit starters are used on a variety of applications and may be controlled by a knife switch, drum controller or push button. For operation when the load is fairly constant, good results are obtained, but when the loads are variable the adjustments generally are tampered with which results in closing the accelerator too quickly. With the use of the lockout type current limit accelerator, the latter very often does not close when the motor is started with practically no load, or when the motor is started after it has been running and is still attaining a fair speed.

In Figures 32 and 33 are shown the photograph and wiring diagram of a starter up to and including 10 H.P., 230 volt D.C. This starter may be snap switch or push button operated and the accelerating contactor is controlled by a voltage drop relay whose operation is outlined. This starter, although thus classified as a current limit starter, has a small time lag for accelerating motor on light load as the relay will not drop out instantly when the motor is started due to the self induced flux in the lower relay coil at the time it is short circuited by the line contactor. The various types of time element starters now on the market are generally the best for most applica-

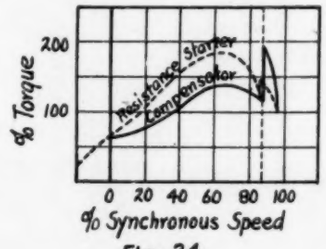



Fig. 34

tions. The dashpot type is generally used and may be oil or air. The timing of the air dashpot is controlled by varying the amount of air admitted to the pot. As the opening must be small, the presence of dust will change the timing.

The absence of oil on the leather washer generally results in the latter drying. Oil dashpots are less liable to clogging than air dash pots, but the timing varies with temperature changes and the heating of the solenoid operating the former. However, the variation in time with either of the above dashpots is generally of little consequence and the simplicity of this type starter and its likelihood of not being tampered with because of the assurance

FIG. 35

that the accelerating resistor will always be cut out, makes it more successful for the general application.

Starters for alternating current squirrel cage induction motors up to 10 or 15 H.P. are generally of the across the line type, either push button operated with overload relay protection, which may be of the magnetic or thermal type, and the manually operated starter. The push button operated starter is now being manufactured by a large number of electrical control apparatus manufacturers and due to the keen

competition and large numbers manufactured, a substantial product is now on the market which gives very reliable motor protection and consequently less maintenance and uninterrupted production.

When a squirrel cage induction motor is started by applying full line voltage to its terminals, a starting current of six to eight times full load current may be drawn from the line. In the case of small

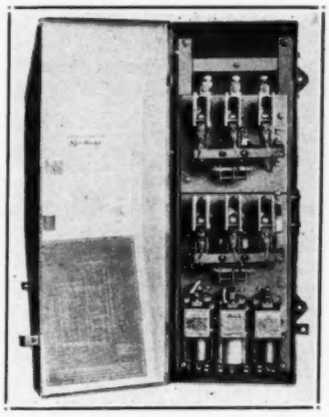


FIG. 36

motors this is not objectionable, but when motors from ten to fifteen horsepower are started in this way, the line disturbances become serious and practically all public utilities have definite regulations regarding the size of squirrel cage motors which may be started directly across the line.

The starting current of a squirrel cage motor depends upon the voltage impressed on the primary or stator terminals of the motor and is independent of the torque required for starting. However, while the starting peak is of short duration, the latter de-

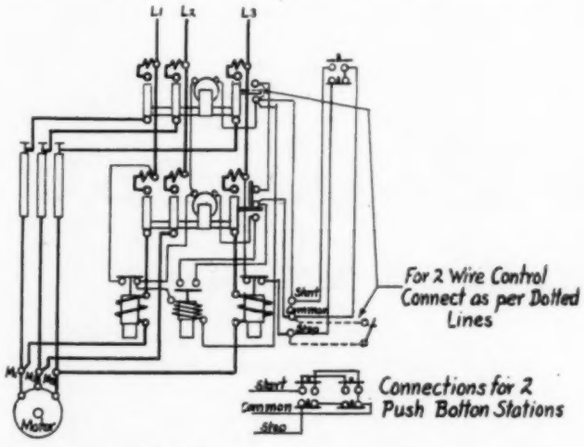



*Fig. 37*
*Primary Resistance Starter Time Limit Acceleration*

FIG. 37

pends upon the character of the load to be started. In order to reduce the starting current to the smallest value, the starting voltage should be reduced to a value which will be a little more than sufficient to start the load under normal conditions. Reduced starting voltage may be obtained by the use of an auto-transformer which has always been until recently preferable, and also by means of inserting resistance in series with the primary winding of the motor.

At present there is a difference of opinion on the application of the auto-transformer and primary resistance starter, some engineers preferring the auto-transformer, while others are just as certain the primary resistance type is more desirable.

Some of the points to be considered in the selection and application of these two types are line disturbance, line current, power factor, power taken from the line, torque, duration of starting period, losses and efficiency, smoothness of operation, ease of control, reliability, ease of repair and maintenance, size, application and cost.

The line disturbance and line current is greater with the primary resistance starter, as the primary

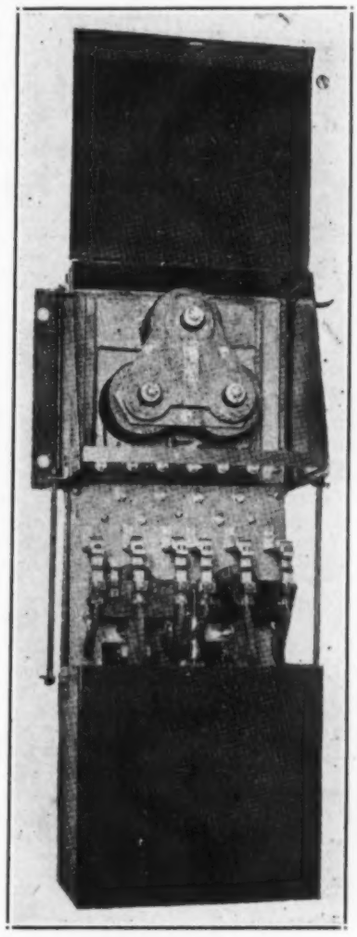


FIG. 38

current required for the auto-transformer is materially less than the secondary current which in this case is the motor current. However, in the use of the hand starter the latter is very frequently abused and the difference in the line disturbance may not be so marked.

The power factor is materially higher with the primary resistance starter due to the latter being practically non-inductive while the power consumed is greater due to the higher starting current and power factor. If the time to accelerate is considered, the difference is not so noticeable, due to the

starting voltage of the primary resistance starter increasing as the motor accelerates, resulting in quicker acceleration and a higher torque.

Figure 34 represents the torque and speed relationship between the compensator and resistance type starters. The transition peak is noticeable more with the compensator type starter because the motor circuit is broken for an instant.

Much smoother operation may be obtained by the use of the primary resistance starter, as the increase

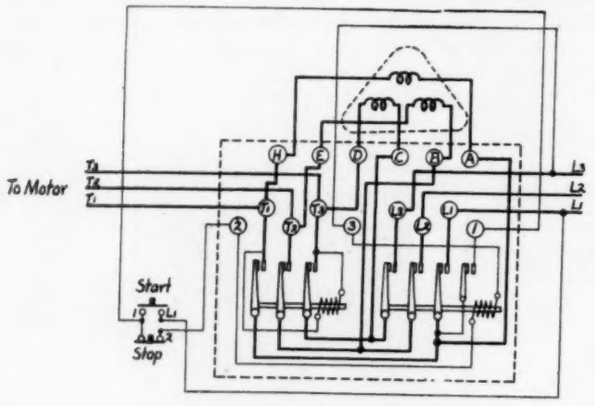



*Fig. 39. Oil Immersed Impedance Starter*

FIG. 39

of starting voltage with the acceleration of the motor results in faster building up of the torque and when the motor is placed across full voltage there is no loss of torque as is the case with the compensator starter. Repairs may be made much easier on the primary resistance type starter as it is far easier to repair or replace the starting resistance than the auto-trasformer. Occasionally the loss of an auto-transformer may be attributed to the high voltage peak during transition from starting to running.

Figure 35 is the photograph of an automatic compensator type starter suitable for indoor or outdoor service.

This starter is oil immersed and is controlled by a current limit transition relay and is designed for very severe and frequent service.

Figure 36 is a push button operated primary resistance starter consisting of two contactors, two overload relays, and one timing relay. Provision has been made to very easily adjust the starting resistance to give the minimum amount of voltage necessary to start the motor. The wiring diagram is shown in Figure 37.

Figure 38 represents an oil immersed impedance type starter. This starter is of the same principle as the primary resistance starter with the use of three reactance coils with adjustable magnetic circuits, the advantage being in the elimination of broken resistor grids, ease of adjustment of starting voltage, and the simple replacement of any impedance coil. This starter has a poor power factor, but for steel mill applications where the power factor is secondary to reliability and continuous operation, the objection does not seem so great. The wiring diagram on Figure 39 shows the coil of the accelerating contactor connected across two terminals of the stator winding.

This contactor has an adjustable air gap so as to function when the motor has accelerated to the proper speed. A dashpot is also used in order to produce a combination of current retardation and time. The air gap must be adjusted so that the contact will close under the worst conditions of load and voltage fluctuation. Under the latter conditions, the contactor is slow in closing and is unaffected by the dashpot, but when the starting load is light the dashpot retards the contactor from closing too quickly.

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# *Discussion: Rules for the Safe Operation of Electric Overhead Traveling Cranes**

**C. L. Baker†:** Members of the Association of Iron & Steel Electrical Engineers, Combustion Engineers, Safety Engineers and Guests: I am indeed pleased to see such a large number of "Steel Workers" present at our opening meeting and your presence here this afternoon makes me feel just as much at home in Chicago as I was in Pittsburgh on March 10, when we held our first Sectional Safety Meeting.

The Safety Division of this Association, since its organization, September, 1925, at the Annual Meeting of this Association in Philadelphia, has been giving attention to a particular safety subject on which you will hear a final report during the meeting this afternoon. We have an interesting program before us and one that will interest every man in this audience whether he be an Electrical Engineer, a Combustion Engineer, a Safety Engineer or a builder of electrical machinery and appliances.

Safety in the Iron and Steel Industrial Field is not alone applicable to the operator of electrical equipment, but is also applicable to the builder. The machine or appliance must come to the user with safety embodied in its construction and then it is that the user, in our case the Iron and Steel Industry, is responsible for the safe operation of the machine and it is imperative that safety measures be taken into consideration by both the builder as well as the operator.

We are featuring today the safe operation of electrical overhead traveling cranes and the President of

*Presented at 22nd Annual Convention June 7th, 1926, Chicago, Ill.

†Chairman Safety Division, Managements Representative, Bethlehem Steel Company, Johnstown, Pa.

this Association has given me some very definite instructions covering the operation of the meeting this afternoon; in other words, I am your craneman for a little while and I trust that since you have all eaten heartily of the lunch, that no one will take a chance of falling asleep with an electric crane operating over your heads.

We want to operate this electrical machine this afternoon in a safe manner, so that no one will either be hurt physically or will have his feelings hurt.

Safe practice is being featured by a great many persons interested in the safety movement and safe practice depends a great deal upon the type of man that is employed to do certain jobs. The type man who should be employed to operate an overhead electrical traveling crane is going to be discussed by a gentleman, eminent in his profession and well known in the Chicago district as well as in other iron and steel centers; active in the Association of Industrial Physicians and Surgeons and its President last year.

It is indeed a pleasure today to introduce our first speaker, Dr. W. B. Fiske, Chief Surgeon, International Harvester Co., who will talk along lines of physical qualifications of a Crane Operator.

**Dr. W. B. Fiske***: Mr. Chairman and Gentlemen of the Convention: When Mr. Wiley's message first came to me, it was something on this order: "Will you speak to this convention on 'The Safety of Operating a Crane?'" Right away I said, "I renege, I know nothing about that." And I was reminded of a little incident that occurred back in my senior year in medical school. The professor was quizzing the class and he happened to have one of the men before him who was notorious for staving off, for avoiding. This man had the gift of gab and he talked and talked and absolutely said nothing in reply to the question. The quiz master let him go on, but after he had run himself down, Dr. Webster, who was the quiz master, leaned back against the wall and said, "Gentlemen, this reminds me of the Ninth Beatitude: 'Blessed are those who, having nothing to say, refrain from giving wordy evidence thereof.'"

I felt that I had a just right to renege Mr. Wiley's invitation, because I was refraining from giving wordy evidence that I knew nothing about the subject.

But that didn't take care of the situation. In a short time I was called again—"Would I take Dr. Shoudy's place and speak on 'The Physical Qualifications of a Crane Man?'"

Let me say, gentlemen, I am exceedingly sorry to hear of Dr. Shoudy's illness. I know him personally, have had the pleasure of knowing him for a number of years, and I regret his illness for three reasons: First, on account of himself; second, on your account, and I know that had Dr. Shoudy been here to address you on the subject, that you would have a fine oration; and third, it would have prevented the necessity of your tolerating me for a few minutes.

When I got Dr. Shoudy's telegram, about three days ago, I thought, "Well, now, I am going to have the pleasure of coming over here and listening to some one make a real talk, and I will just be a good listener," and I was very much delighted to think that I could be a wall flower, because we have just passed through a three days' session in Philadelphia of which I was chairman, and it is not an easy job. However, the next message, I think, was Saturday morning, and that was to the effect: "Would I take Dr. Shoudy's place?" And again I was reminded of the Scotchman.

I know it is a dangerous thing, gentlemen, to tell a story, because it is surprising how fast stories travel over this country, but I am going to tell this because it illustrates my feeling this second time.

They tell of a Scotchman whose wife was on her death bed. She was going to die and Sandy knew she was going to die. Before she drew her last breath, she called Sandy to her bedside and said, "Sandy, before I die I have a request I want to make, and I hope you will grant it."

Sandy was very reluctant to grant her request, because he had been there before, but he decided that he couldn't refuse his wife's dying request, so he said, "Very well, I will grant it."

She said, "When I die and you are having the funeral, I want you to ride in the front carriage with my mother."

The blow was almost too much for Sandy, but he braced himself and thought, he couldn't refuse a dying request and so he said, "Weel, ae gie you my promise, and I'll keep it, too, but you sure hae spoiled the day for me."

That is the way I felt, gentlemen, when I found that Dr. Shoudy was ill and that I had been asked to take his place. Dr. Shoudy was to speak to you on "The Physical Qualifications of a Crane Man," and I shall attempt to give you very briefly the qualifications from a medical standpoint that a crane man should have.

Many of you I know are interested in the safety game, and when I suggest to you the physical qualifications of a crane man, I hope that every one of you gentlemen, whether you are especially interested in the safety game or just from an electrical standpoint, I hope every one of you will sit in with me and think, "Well, I want the crane man to be physically fit, because I am working with him, or underneath, or somewhere, where, if he is not physically fit, he may turn on the juice," so to speak, and you gentlemen are just as much interested in selecting a good crane man as I am.

The first thought that I had when this subject was suggested was Age. What age should a crane man be? It seems to me that we should select an age that has given up boyish tricks, if you please, given up the little stunts that we perhaps were all interested in when we were 15 and perhaps 20. It seems to me that if we would put our limits between the years of 30 and 45, we would avoid the indiscretions of youth, avoid possible kiddish tricks. And again, if we go to 45, we will avoid any possibility of holding a man in line too long, until he has begun to slip.

My next thought is that the crane man should speak the language of those with whom he works In this country of course, English. However, if that crane man should be operating with a lot of Germans or Poles, or whatnot, he should speak that language. A lot of these things I merely suggest, there is no need of going into explanation, because those things

*Chief Surgeon, International Harvester Company, Chicago, Ill.

are just the things that you would suggest, and I am not going to go into detail on most of these points that I mention. There are a few that I want to elaborate on just a little bit.

My next point is, if I am selecting the crane man to work over my head, I want to know something of his family history. Does he come from a family in which one, two or three have become insane? Does he come from a family where there are one or two epileptics? While it is true that insanity and epilepsy are not exactly hereditary, it is also true that we frequently find in one family one or two insane, one or two epileptics. I want to know something of that man's family history before I will stand under him and allow him to operate this crane over my head.

There are other things that would enter into the family history end of it, but those two I give you just to point out my thought in securing a family history.

I want to know a great deal about this man's personal habits, his personal history. I want to know if he himself has, if you please, been in Elgin for a period of six months or a year. That is one of our state insane asylums. I want to know if he has ever had epilepsy. I want to know if he has any peculiarities, extreme nervousness, does he get excited easily? I want to know all that before I am satisfied to sit under that man and let him run a crane back and forth over my head a dozen times every hour.

I want to know whether the man is subject to drinking, especially in these days. There are a number of things in the personal history that you, as safety men, should know. These are just three that I have mentioned. I just want to touch the high spots. You want to know all about this man from a personal standpoint. My own opinion is that that if the crane man was selected from perhaps some other department, in order to give you a man who has already proven himself in another department, I think I would have more confidence in that man than if I went to the gate and hired a man and took his family history, his personal history and so on and so on. I think I would have a lot more confidence in the man as an operator if we took him from a department because of his good work, because of his steadiness, because of his sobriety, his ability at all times to hold himself, because of his good judgment —and when I speak of good judgment, it seems to me that there is a qualification that a crane man should have more than the ordinary intelligent person.

It may be that I am going to step out of my medical field and step into your field. If so, gentlemen, I know you will pardon me, but it seems to me that if I were going to select a crane man for you, I would want a man who knew a great deal more about electricity than the average good employee. About a month ago, a man who had no business on the crane climbed up—I think he was alone, I don't know whether the crane man was there or not, but anyway, this chap had no business on the crane. No one knows just how it happened, but anyway, he got mixed up with 440 volts and the terrible shock caused him to plunge off of the crane a distance of about twenty or twenty-five feet and he was killed instantly.

Now, that man didn't have the average intelligence from an electrical standpoint. He got up there and became mixed up with some wires. He didn't have average intelligence; it seems to me, that a man with average intelligence would know enough to keep away from wires. This man didn't know.

The crane operator whom I select for you must have more than the average intelligence from an electrical standpoint.

It seems to me that in this position, too, a married man would be a little bit more steady than a single man. However, I wouldn't quarrel with anyone on that point. If the man filled the job from every other standpoint, all right. But it seems to me that a married man is a little more likely to have sowed his wild oats, a little steadier, perhaps, on the job.

When it comes to the physical examination, the height and weight, it doesn't seem to me, have any bearing on it. I don't think that a big man has anything on a small man when it comes to operating a crane safely. The rest of the physical examination I would be very sure of.

First, in regard to his vision and hearing. I don't believe I would be willing to accept a crane operator whose vision was not perfect, and I would test him both from far as well as a near viewpoint. We men who have been in the industrial game from a medical standpoint have learned this, and I will say honestly that it has only been in the last few years that we have grown wise to this. We not infrequently in our physical examinations find men who can read the 20/20 line at a distance of 20 feet perfectly, yet if you give them a newspaper and let them hold it a foot away, they can't see it. In other words, the near-sightedness and far-sightedness must be tested. I want to test a man from both viewpoints before I put him to operating a crane over my head.

I want his ears to be equally good. I want a man to hear everything, every command; if there is a cry, an alarm or anything o fthat kind, I want him to be on the job with his ears as well as his eyes.

A man should have two good legs and two good arms. I don't need to go into explanation as to these qualifications. A man should be "on his toes" all the time. But most of all, gentlemen, it seems to me a qualification of importance is that a man should be cool and collected, no matter what happens, not excitable, no matter what emergency may arise. He should be in command of himself.

General good health, of course, is a natural requisite and one that you would think of as quickly as I would.

There are a few conditions that I want to call especial attention to, because when these conditions exist, bad accidents might occur because the operator might simply become unconscious. Blood pressure is the first thing that comes to my mind. We have in the last few years heard a great deal of blood pressure, and, if you will bear with me just a few minutes, I want to go a little further into that than I otherwise would, because I feel that it is a very interesting subject and all of you are much interested in it.

I don't want you to misunderstand me when I say that I feel that the question of blood pressure has been just a little bit overdone. Now, let me repeat, I don't want you to misunderstand me. What I mean is this. Five or six years ago, if we had found a man who had a blood pressure of 180 we

immediately threw up our hands in holy horror and said, "That man is not fit to work; he must go home and he must go to bed for six months," and so on and so on.

I don't believe that now. There is another condition that must be present before I would even admit that that man was in danger. You have all heard more or less of this subject. There are two extremes. There is a time when the heart is beating that the pressure is the greatest. That is one extreme. That is when we speak of the pressure being at the systole, or highest point, 180. There is an opposite condition when the heart is at rest. Usually that point, in a normal condition, is below 90. These 90 and 180 points are based on the actual lifting of a column of mercury. That, however, doesn't need to enter into it. Arteries are exactly the same as a fire hose, if you please. If you put 180 pounds pressure on a fire hose and keep it there, when that fire hose is only expected to take a pressure of 100 pounds, it is not going to continue very long before something happens. On the other hand, if that fire hose could have the pressure removed for an instant, the same length of time as the high pressure exists, it is going to last longer. If that high pressure, if you please, will go from 180 down to 80, there is an interval of rest, and that is the safety device that nature applies.

A while ago I said I didn't agree with the statement that a man who had a high pressure of 180 was in a dangerous condition. I do not, if the low point of pressure is down to 80 or 90, if you please, because the vessels have a period of rest, a time to recuperate from this high stretching of 180. I do agree that 180 is a high pressure if at that interval of rest the blood pressure only goes to 120.

Here just a few days ago I took a pressure of 220 and the low pressure was 120. Now, that man is in bad condition, because the vessels don't get a chance to rest, to recuperate, during that instant when the pressure is supposed to be low. I want to know how much pressure this crane man has, I want to know if his pressure is 220 over 120, because if it is way high and if the interval of rest is much higher than it should be, I know very well that that man is likely to break a blood vessel at any time, just when he is hoisting something, if you please, and I am working under him. I want to know what that man's blood pressure is. I want to konw what the condition of the heart is.

It is not infrequently that we have men drop over. We never know whether they fainted, fell and struck their head and died or whether they died and fell. Now, about nine out of ten of such unfortunates die as the result of a heart weakness, either directly or indirectly. It may be the result of a sudden giving way of a heart valve, in which the man simply collapses.

Here just a few years ago a man came into my office. I was about fifteen feet from the door. He walked towards me, got halfway between the door and where I was standing and he said, "I was having a little dizziness this morning"—and all the time he kept walking towards me and I was edging towards him. He got to me, or I got to him, we met, he said, "I guess you better catch me." I threw my arms around him and he slumped down to the floor and was dead. His heart!

I want to know what is the condition of that crane man's heart. I don't want him toppling over just when he is doing something that is a menace, not to himself, but to all the employees about him.

I want to know what the condition of the man's kidneys is. While this is a little more remote than the blood pressure and the heart condition, it does have a certain bearing and I want to know that that man is in good condition from the standpoint of the kidneys. It is true that the unconsciousness that comes as a result of faulty kidneys usually is the end of the illness. A man may have bad kidneys for years, go on and on and on and never have a convulsion or unconsciousness or anything of that kind. However, they might have it, and they do have it, although it is irregular.

These are most of the physical conditions that I would investigate if I were selecting a crane man to work for you and work for me. After I have gone all through this and selected a man who I am going to employ, I am going to say to that man, "I want you to come in to me every three months! I want to check up on you; I want to see if your eyes still remain in good condition, your ears are all right, your blood pressure is all right, and all these other conditions." That is one place where we fall down, gentlemen. We select a high grade man from a physical standpoint and put him on the job and then forget him. I want to examine this crane man at least every three months to check up on him to see whether he is 100 per cent perfect.

While I am on my feet, I just want to repeat something that I said to Mr. Baker before the meeting began. I feel that a lot of credit is due the safety men. It so happens that I have been with the Harvester Company for twenty-five years and have had an opportunity of watching the changes that have taken place as regards accidents for that period. Ten or fifteen years ago it was nothing unusual for me to have in the hospitals of Chicago as many as ten to twelve broken legs, other injuries as well. I mention this just to give you a line on the point that I am going to make. Now I haven't a single, yes, I have one, I have one broken leg in Chicago. I don't think I would have to go back twelve years, less time than that, there has been a very marked change in the last ten or twelve years in the matter of cutting down accidents, and I attribute that, gentlemen, to the safety appliances and the progress that you are making in educating the employees to be safe, for themselves and for their fellow workmen.

**C. L. Baker:** We are indeed fortunate to have the privilege of listening to a man who has spent 25 years in the medical and surgical work of the Iron and Steel Industry. Dr. Fiske has given us his ideas gained through years of experience and who could be better fitted to speak from actual knowledge than one who has been connected with the medical side of our industry? He has not given us visionary theories, but has drawn from his store of knowledge obtained in examining and passing men for employment and taking care of some of them after receiving injuries.

The Safety Division of this Association, since its inception last September, has had the hearty co-operation of the Iron and Steel Industry and that is the Industry, Gentlemen, that it is our particular

privilege to co-operate with in the prevention of accidents; particularly in the electrical field of operations in the Steel Plant. At the Annual Meeting of this Association in Philadelphia last year, the first day of the convention was allotted to inaugurating the Safety Division and with Mr. L. H. Burnett, Assistant to President, Carnegie Steel Co., in the Chair, co-operation was a particular point stressed. We were seeking the co-operation of all organizations and individuals in our efforts to make the Electrical Department in our plants a safe place for men to work. At that meeting we had on our program, two eminent and outstanding safety men in the country; one of these gentlemen on our program that day being Mr. C. B. Auel of the Westinghouse Electric and Mfg. Co., who was at that time President of the National Safety Council; the other gentleman being Mr. Henry W. Reninger of the Lehigh Portland Cement Co. and Vice President of the National Safety Council in charge of industrial safety. Both of these gentlemen assured us of their hearty co-operation and we have received it. Our safety efforts deal directly with the electrical department of the Iron and Steel Industry and do not in any way interfere with or overlap the broad activities of the National Safety Council. We are just a little closer to the Metal Section of the National Safety Council than any other division of that great organization because all of our Safety Engineers, with few exceptions in the Iron and Steel Industry, are members of the Metal Section of the National Safety Council The friendly interest that we have received during the past year from men active in National Safety Council affairs has been most encouraging and on our program today we have the highest official of this great organization as one of our Speakers. A man who has been active for years in safety work and is connected with one of the largest electrical public service organizations in the country; has been honored from time to time with various offices in the National Safety Council, until today he comes before us with a message on safety as President of the National Safety Council. I take pleasure in introducing Mr. Charles B. Scott, a Chicago man, personally known to many of you and at the helm of the greatest safety organization in the world:

**C. B. Scott***: Mr. Chairman and Gentlemen: There seems to be much of the Chicago atmosphere about this meeting. It was evidenced in the welcome extended to you by the Mayor, whose name I am sure Mr. Shoemaker does not know. Also in the reference to this city, as a "wild town," made by Mr. Wiley. Calling our city a wild town reminded me of the nervous Chicago man who stepped into the telephone booth in New York and called Brooklyn. When he came out of the booth he said to the young lady operator, "How much was the call?" She said, "It was a dime" "What?" said he. "Ten cents," was the reply. He said, "I am from Chicago, and there I can telephone to hell and back for a dime." "Of course you can," said the young lady "because it is in your city limits."

It really gives me pleasure to meet with you today, and were it not for the fact that I am supposed to say something I would thoroughly enjoy the occasion. I am pleased to meet with you because it was your organization that gave birth to the National Safety Council. So far as I know the thought of its creation as a national institution originated with one of your members. Among your members are some of my best friends, with whom I have been associated in safety work for many years. Such as your distinguished veteran member, Mr. Greenwood, corpulent Mr. McKenna, and John Oartel, whose society I seek at your conventions. These and many others among you have contributed much to industrial safety.

No extended description of the National Safety Council and its aims and service is necessary. Most of you are familiar with these because you have been very closely identified with the work through the Metals Section of the Council. There are no selfish motives in its perpetuation, not even mercenary ones, for it is a non profit making organization. Its service is made possible only by the volunteer and gratuitous contributions made by the many who give of time and money because of their continuing interest in the cause. There are no paid officers in the Council, no one receives pay except the office staff at headquarters. It is unlikely there is another such organization that receives so much valuable and unstinted service without money compensation being paid therefor. This unselfish service so freely given is no doubt responsible for the advancement of the cause of accident prevention and the growth and increasing influence of the Council. The steel industry and the service of many of your members have been conspicuous in this very worthy contribution, in bringing safety into recognition as a definite part of industry and of life. The Council can only meet its ever increasing responsibility and duty by a continuance of such unselfish interest and helpful service.

There is not a full appreciation of the value of the National Safety Council as an organization, by many of the industries, and particularly by many of those employed in industry as safety engineers or safety directors. Your chairman, in his introduction, made reference to the Bureau of Safety with which I am associated. This bureau is an incorporated service organization, a subsidiary of the Middle West Utilities Company. It serves in an advisory way as the head of the safety organization for a group of utilities known as Insull properties. These utility companies are distributed over some twenty different states, giving service of one kind or another to more than two thousand communities. About fifty thousand employes are thus within the scope of the safety activities of this bureau. It is in my connection with the safety work of these utility companies that I have found the real value of the helpful service obtainable from the National Safety Council. It would be impossible to successfully carry on accident prevention work with such a large group of employes in such diversified employment and diversified locations if help was not obtainable from others who are engaged in similar work. The National Safety Council serves as a clearing house for such information. Accident Prevention is now a rather definite science, in which, if one is to be successful, he must keep abreast of the times and must keep informed as to new developments, either in the line of better instructed employes or in the improvement of mechanical safeguards. The one who does not keep so informed cannot realize a full measure of success.

*President, National Safety Council and Chairman Bureau of Safety, Mid-West Utilities, Chicago, Ill.

Experience with the National Safety Council and with some of the National Trades Associations is convincing that the services rendered by such institutions is not generally utilized as it should be. To some extent this situation may be chargeable to these associations, but in the main it is chargeable to the membership. These member companies either do not take the trouble to investigate the character of service obtainable or give it very indifferent attention and make no real application of it to their own needs. An instance is recalled where a representative of a western utility spent several weeks visiting concerns in the East and Middle West, seeking proper specifications for a lineman's belt. In the course of his investigation and on his way to the Pacific Coast, he stopped in my office and made his wants known. I laid before him a copy of the report of the Accident Prevention Committee of the National Electric Light Association, calling attention to standard specifications for such a belt. He expressed himself as delighted and asked me the name of the publication. The gentleman was then informed that he had a number of copies of this particular publication in his office, printed in separate form as well as in the proceedings of the National Convention. If he had taken the trouble to inform himself as to the work of this committee and this association, he would have saved the time and expense spent in his extensive investigation. Such instances are not rare but are frequent and it is amazing how much of the good work done by such associations is lost because of this inattention and indifference.

The steel industry during the past twelve years has made an advancement in accident prevention that has not been surpassed, if equaled by any other industry. If those who were directly responsible for this advancement were consulted, I am sure they would verify my thought that the success attained was in a large measure due to the close contact which safety men in the steel industry, generally, have with the National Safety Council through the Metals Section. I urge those of you who are particularly interested in safety in your plants, to make a careful investigation as to the entire service rendered by the Council which may be of assistance to you. There are, no doubt, many pronouncements and findings, the result of a compilation of experience which would be of great value to you and of the existence of which you do not now know.

On such an occasion as this, a speaker tries to leave with you some outstanding and definite information which may be of helpfulness in your work. There are many essential factors in industrial accident prevention, each one of which bears its own degree of importance in any general plan. Those who have been engaged in the work for many years recognize the relative value of these several factors and take account of them accordingly. One of the most essential fundamentals in industrial safety lies in the proper selection, instruction and training of employees, and these elements as factors in any successful plant are not generally and fully appreciated. A very careful analysis of serious accidents in any industry will reveal that the lack of proper instructions and lack of close and constant supervision has been responsible as the cause. No safety work can be fully successful where careful instruction and supervision does not exist, no matter how perfect the plan may otherwise be and no matter how much attention is paid to the other factors. These statements should, without further comment, cause you to give particular attention to the supervising heads and foremen in all of your efforts and should convince you that their hearty co-operation in your plans will assure you of a greater degree of success.

It is hoped that the matters which have been brought to your attention in this rather brief statement may be of help to you in maintaining an interest in safety, in securing up-to-date practical information which may help you and in suggestions for a better selected and trained personnel, particularly in the supervisory forces. If these things are helpful to you, this opportunity of speaking to you and officially welcoming you by the National Safety Council is well worthwhile. I thank you for this privilege.

**John A. Oartel***: Mr. Chairman and Fellows: The Safety Section of the Association of Iron and Steel Electrical Engineers is nine months old, and it is a right healthy infant. That was proven in Pittsburgh last March when we had one of the peppiest safety meetings that it was ever my privilege to attend, and I have been around quite a bit, as Mr. Baker has told you. Yet there are still some people who are asking, "What is it all about, this Safety Section of the Association of Iron and Steel Electrical Engineers?" And letters have come to my desk voicing that question: "What is it all about, and why are you going into safety? Why not stick to your knitting, the promoting of electrical things in the iron and steel industry?"

Well, there is a reason, gentlemen, why we—and I say that because I am a member of this Association now—there is a reason why we have gone into safety. That brings up the question which is very pertinent, and that is, "Why should we have safety at all? Why all this agitation about safety today? What is it all about? Why put on propaganda and education for safety?"

Well, gentlemen, that question was answered to me two years ago at Harrisburg, Pa., in a way that I have never heard it answered before. I was down there to address a meeting of Pennsylvania Railroad foremen from the shops, and after I had given my talk, the meeting split up into groups and went into different school rooms in the schoolhouse which the meeting was held in, and I went around and looked in on them. They had a question written out on paper for discussion, and it was this: "Is the law of self-preservation, the love of life, the desire to live that every man has right inside of him—is that enough to keep a man safe in a Pennsylvania Railroad shop?" And they all said "No." That is why we have safety, because the law of self-preservation in a shop, on a railroad, walking the street, in a man's home, is not enough to keep him safe. That is why we have safety organizations like the National Safety Council that Mr. Scott has told you about. That is why we have safety committees in our manufacturing establishments, and that is why, if you go out on the streets of Chicago today, you will see "STOP" and "GO" signs to tell you when to stop and when to go, because in this busy, bust-

*Chief Safety Director, Carnegie Steel Company, Pittsburgh, Pa.

ling age, even though we have right in our beings a dominant, persuasive law which tells every man to look after his own skin first, it is not enough to keep him safe.

Well, what are we going to do about it? Our Association is on the job, as it always is in progressive things. It has lined itself up definitely, and has said, "We are going to promote safety along with production, along with efficiency." And so here we are, and we have something definite to offer this afternoon as the result of the deliberations of the officers of this Association.

Mr. Scott said some real things in his address, and, gentlemen, it was a pleasure to me to listen to his talk, coming as the result of experience, because he knew things, he knew how things had happened, how accidents happened, and he told you, and he told you the reasons.

Now, it has been a very great privilege to me, as Safety Director of the Carnegie Steel Company, month after month to report to Mr. Wales, our Chief Electrical Engineer, that in our electrical departments there have been no lost time accidents as the result of flashes and as the result of burns from electricity. We have several of our electrical engineers here today, Mr. Cummins who has talked, and Mr. Davenport over there, and Mr. Miller on the right, there may be one or two others here, I haven't seen them, who will bear me out and say that the thing that is producing accident in connection with electrical equipment is not the hot wires, but it is the lack of co-operation from the other fellow who has to do with electrical equipment.

So that is the thing we are going to get at this afternoon, we are going to present to you some rules that will enable the man in the crane cab, who is personified by our good friend, Mr. Baker, the crane operator, and the man on the ground who hooks up, to get together and perform their work in safety.

**C. L. Baker:** The President, together with the Board of Directors, selected a Committee several months ago to prepare a set of rules covering the Safe Operation of Electrical Overhead Traveling Cranes. The officers of this Association asked all the Iron and Steel Companies in the country to submit a copy of their crane rules, and after careful study and consideration of all available information they have worked out a few simple rules for the Iron and Steel Industry.

These Rules have been formally approved by the Board of Directors of this Association and they will now be submitted by the Secretary for your consideration and adoption.

**F. W. Cramer*:** Secretary National Association, presented the following rules:

## A. I. & S. E. E. RECOMMENDATIONS COVERING RULES FOR THE SAFE OPERATION OF ELECTRIC OVERHEAD TRAVELING CRANES*.

### Rules for Crane Operators

(1) The operator should be examined by a Foreman or someone designated in order that his familiarity with crane parts and their uses, as well as his ability to safely operate the crane may be determined in practice and certified to by the examiner.

(2) The operator shall enter or leave his crane at the designated places, making use of the steps or ladder provided at those locations and having both hands free. All materials too large to be carried in pockets shall be raised and lowered by means of a hand line. The hand line must not be attached to the person of the operator.

(3) No one but the craneman shall be allowed in the cage except for repairs, inspection, or instruction of new men or for safety of men working on the crane runway.

(4) The operator shall keep his crane clean and free from all loose boards, tools, bolts, or other objects which may fall on men below or may cause tripping and falling of repairmen when working on the crane.

(5) The operator should inspect his crane at the beginning of the turn or at least once each shift and report at once, any mechanical or electrical defects, especially noting the condition of cables, limit switches, signal gongs and collector shoes.

(6) The operator shall be responsible for the proper oiling and greasing of his crane and he should report any defects in the oiling system on any part of the crane.

(7) The operator, when about to handle material with his crane, shall devote his entire attention to his work and shall pay careful attention to the following points:

(A) Is the hitch of proper length and is it safe?

(B) Is the signal given by the proper party and does the operator understand the signal? If in doubt he must not operate .

(C) Can the load be carried without passing over the heads of men?

(D) Will load clear all obstacles?

(E) Test brakes by means of a short lift and return of controllers to "off" position.

(F) Allow no one to ride the hook or load.

(G) If craneman discovers men on crane runway, he should stop his crane until proper protection is provided.

(8) The operator shall avoid bumping other cranes on the runway, but if he is ordered to do so, he must move the crane slowly with regard to the safety of men working on or below the idle crane.

(9) The operator must not make side pulls unless ordered to do so by a Foreman.

(10) The operator must be sure that his controllers are in the (off) position and switch opened before leaving the crane, and in case of failure of power the controllers must be immediately set in the "Off" position.

(11) In case a controller sticks the operator must pull the main switch at once.

(12) While repairs are being made to the crane, the operator must stay on the job and help with repairs. If ordered to remain in the cage, he must not operate any motion unless he is told that every one is safe.

*Asst. Electric Superintendent, Bethlehem Steel Company, Johnstown, Pa.

(13) When the operator is inspecting, repairing, or lubricating his crane, the main switch must be locked in the "off" position.

(14) In case of a fire on the crane, the operator must use the fire extinguisher provided and must notify the Foreman, who shall see that the extinguisher is refilled promptly.

(15) An operator must not operate his crane if he is not physically fit to do so. He should report to his Foreman at once.

(16) The operator must signify his understanding of these rules and must realize that they are intended to help him safeguard the lives of his fellowmen.

**Rules for Floormen**

(1) Floormen when signaling to the crane operator must use the approved crane signals and above all, they must be sure that they do not confuse the operator.

(2) Floormen must be responsible for all slings, chains and hooks and for their proper use in order to make safe hitches, bearing in mind the capacity of the slings and of the crane.

(3) Floormen shall be sure that the crane trolley is centered over the lift in order to prevent swinging of the load.

(4) Floormen must adjust the slings and chains so that they will not strike men on the ground when the crane is moving without a load.

(5) Floormen shall not ride the hook or load or permit others to do so.

(6) An extra man should be in the crane cage to warn the operator when men are working on the crane runway except where approved track torpedoes are used.

**C. L. Baker:** The question of rules are now open for remarks and the Committee that have been working on these rules, the Board of Directors, the Safety Committee and everyone who had anything to do with the preparation of these rules are looking for constructive criticism and we trust no one in this audience will hesitate to discuss any feature or make any suggestion which they may have in mind.

**Question:** I don't see where you have anything in the rules about testing of limit switches. In our plant they are supposed to try them out in the morning the first thing, before they operate the crane, and then probably once during the day as well.

**Question:** Is there any provision contemplated for an audible signal on the crane? The object of that would be to warn anybody who might be standing in the way of such a movement and wouldn't see it. That can happen. I have seen it.

**C. L. Baker:** The committee that has been working on these rules and the Directors of the Association are making notes of these questions that are asked, and the problem will be whether or not the suggestions that are brought up will be incorporated in these general rules or if they shall be left to the individual company plants either to incorporate in their particular rules, in addition to these general rules, or, as I said before, whether they should be a part of these general, broad safety rules for crane operation.

**R. S. Shoemaker*:** Mr. Chairman, I am not a member of this committee, but may I say a word on the first question? The gentleman asked about the provision for testing limit switches. We don't all have limit switches. Some of our cranes in some of our plants are not equipped with mechanical limit switches. Some of us are still depending on rules such as Mr. Cummins spoke about, we fire the man if he goes thru blocks. We don't want to put anything in these rules that will be arbitrary and force anybody to put limit switches on their cranes if they don't want them, if they have good and sufficient reasons for not doing so, although we think they should. I think they have tried not to put anything arbitrary in the rules. I think that testing limit switches is pretty thoroughly covered. This is just my personal opinion.

Audible signals is another question that was asked by a member. In one of these rules it says the crane man shall only take the standard signals adopted in that plant. Now, if you want to adopt a set of signals in the plant and state that under some certain set of conditions or under some cranes you could take audible signals, well and good, but you can see how cumbersome this standard set of rules would be if you add everything of that sort to them.

**Question:** I wanted to know if there was any limit switch to prevent the over-hoist of the load. The reason I asked that is, it is considered a very good point in connection with elevators and in some states they have given it very great consideration, because they have prevented accidents where the crane operator either went to sleep or forgot or there was a defect somewhere. Now, if it is considered a good mechanical point to put on an elevator, to have limit switches both at the top and bottom terminals, there should be some provision made for your electrical crane also. If you are going to have rules which are to be handed to the proprietors and the owners of the different plants for making the plant safe, there should be some provision made to overcome such defects as that. That was the reason I asked the question.

**R. S. Shoemaker:** There are a number of satisfactory, at least several satisfactory limit switches that are standard equipment on the market. You may put them on or not, just according to your policy in your plant. I don't presume that there is any piece of apparatus, limit switch or whatnot, that is absolutely fool-proof. Mr. Cummins mentioned here a while ago that his plant was equipped 100 per cent with the best limit switch that he knew anything about, after trying out a number of switches, and that he had from one to one and a quarter per cent of failures even with such limit switches. He feels that he has gone as far as he can possibly go. I don't know how you could go any farther.

**Member:** I think it would be advisable to have some rules to forbid the crane man to run in the limit switch continually. The limit switch is there for safety, but as soon as a limit switch is installed, they use them for everything, every time they hoist. There should be a rule for that, to forbid it. If a mistake is made, that is the time the limit switch

*Supt. of Maint., American Rolling Mills Company, Middletown, Ohio.

should act. But they make a practice of using it all the time. I think a ruling to that effect would help a whole lot.

**R. S. Shoemaker:** That, in my opinion, is a question for the manager of the department. In pretty nearly every mill you will have one or two cranes where it is utterly impossible to do the work without tripping out your limit switch. I know of several, and I think pretty nearly every operating man here can mention one or two cases. That is an unfortunate condition, it ought to be remedied as soon as possible, because it is dangerous, a man gets to depending on it.

Now, you can have your individual rules, you can cover that in whatever way you see fit. You can absolutely prohibit the crane man from doing that, and if you stand around and watch him long enough, maybe he won't do it. It is one of the awfully hard things to prevent. If the limit switch is good and it is working apparently 100 per cent, lots and lots of operators, unless they have very close supervision, will make a regular practice of letting the limit switch do the work. He will do it up until the time that some day it won't work, then somebody will be hurt and he may lose his job. I think it is a question of management. You can add that rule to your own individual rules if you wish. We didn't feel that it could very well be added in the standard rules that might be adopted as general to cover all plants. That is what we are aiming at.

**Member:** The crane man is supposed to keep his crane clean and clean the controllers. There is nothing said as to what he should use. One of my foremen instructed the crane man to use gasoline to clean the controller contacts, also the inside of the controller. He left the switch on and accidentally pulled the lever. Of course, that ignited the gasoline. He was a distance away from the ladder The fellows saw the flame up there and they threw a couple of Pyrene extinguishers up to him and he started putting it out. By the time he had it out he wasn't conscious. He was a distance away from the ladder, too, and it took some time to get a ladder.

I think something should be said as to what is to be used to clean the controller.

**C. L. Baker:** These are all very good points, gentlemen, that have been brought up for discussion. Anything further?

**Member:** I haven't anything to offer regarding the set of rules that has just been read, but I would like to tell you of an experience we had at our plant last Tuesday. A motor inspector was up on a gantry crane inspecting and adjusting the hoist brake, and with the full knowledge of the operator. He had made the adjustments to this hoist brake, the operator moving the hoist up and down, and he stepped off the bridge and motioned to the operator that everything was all right to go ahead with his regular work, which the operator did. The motor inspector stepped back on the trolley of the crane and the fellow was performing his regular job when all at once he had to land a load of billets that took the trolley under the A-frame on the end of this crane. This motor inspector was up there and of course he got caught between the knee and the hip and had his trousers torn off. Luckily he only had a few lacerations to each leg and it took only about a week's time for him to get around. But since that accident we have made a rule that any repair man, electrical or mechanical, when at work on a crane, the crane cannot be used in the performance of its regular job. I mean by that, if there is either a mechanical or an electrical man up there, the crane is not to be used in its regular work. In other words, it is to be out of commission as long as the electrical or the mechanical man is up there That was an accident that occurred in that electrical department, of which Mr. Wiley is the head, the first one in over five years, and that is the rule that we have made. It might do some of the fellows in the room some good to know that.

**R. S. Shoemaker:** That, to my mind, sounds like a very live suggestion. I want to ask Mr. Cramer, is that covered in the rules?

**F. W. Cramer:** It is, in Rule 13. I think Rule 12 would cover that, but, just as the gentleman brought out, it would be within the rule. "While repairs are being made to the crane, the operator must stay on the job and help with repairs. If ordered to remain in the cage, he must not operate any motion unless he is told that everyone is safe." Evidently the man on the crane was given such a report.

**Member:** The man on the crane doing the job stepped off on the runway and signaled this fellow that it was all right, but the crane operator went on with his regular duties and forgot that the man was standing on this platform in the middle of the bridge, and he stepped back on to the trolley. The point of this rule is to not only keep men from being injured, but it is to keep the operator from having two things on his mind, the man up on the walk, on the bridge of the crane, the man on the trolley of the crane, and his regular job, too. The crane man cannot take signals from a man up above him and signals from the man on the floor. He has to stop doing one thing or the other. He has to stop taking signals from the man above doing the adjusting or the repairs or the man on the floor handling the load. I think myself, after talking it over with all the electrical men and our mechanical men, it seems as if it might cause a good deal of delay to put a crane out of commission while the repair man is on it. Nevertheless, I believe it is safety first.

**R. S. Shoemaker:** Do you feel that it ought to be positively stated in the rules that if a man has work to do on the crane, the crane must not do its work, and that the crane man must not operate that crane until that man has left it?

**Member:** Except as the man tells him. The motor inspector in this case was adjusting the hoist brake and it was necessary for him to operate the crane. You cannot shut the crane down altogether and pull the main switch. The motor inspector wants to see this part work and he is to inform the crane man when he goes up on the crane that he is to examine the hoist brake and he is not to operate any movement except that particular movement, and then, when he gets through with that, he is to notify the operator that he is through and then get down off the crane. The operator isn't to move the crane for any other work while that man is on the crane.

**R. S. Shoemaker:** I would like to have some other expressions of opinion on that subject to see

whether we ought to add another rule to these rules. I would like to ask Mr. Standing if he would like to say anything on the subject?

**A. J. Standing***: I have been an interested listener here, being more or less responsible for the whole committee line-up. There are some points that are of interest. The first question asked—I will just take those up for a moment before I go on with this other work—regarding the use of limit switches—limit switches are mentioned in Rule No 5: "The operator should inspect his crane at the beginning of the turn or at least once each shift and report at once any mechanical or electrical defects, especially noting the condition of cables, limit switches, signal gongs and collector shoes." That rule recognizes the presence of limit switches and signal gongs and it requires the crane man to ascertain whether or not they are now, at the beginning of this shift, in operating condition.

Rule 13 touches somewhat on the last question: "When the operator is inspecting, repairing, or lubricating his crane, the main switch must be locked in the 'off' position." That takes care of the condition of the crane when the operator himself is on the crane and eliminates the danger of some other man going and seeing an idle cage and getting in and going ahead with the operation of that crane.

Now, the question of repairs being made on the fly, while the crane is doing its regular work, I don't think is really safe to consider at all. I think if we go to repair a crane, we certainly should stop every operation for the safety of the man who is repairing that crane, and I really can't see the necessity of introducing a rule that says that a man can't continue his regular work of the crane while it is under repairs, because that condition should never be allowed to exist. That crane must be shut down when the repair man is working.

**M. M. MacDonald†**: Mr. Chairman, it seems to me that these rules as they are made up now and are before the convention are very good and that the proper thing to do would be to adopt them as read. As several men have mentioned, it is possible to add a great many more things and make that a very bulky thing which perhaps would not be applicable to every and to all plants throughout the country. As it stands now, it seems to me that it cannot be challenged. There are a great many things that I and every other man in here, perhaps, knows of that he could add to that set of rules that would apply in his own plant. In fact, I have a list here of those that we use in our plant, and I might say that all of those that are before the convention now are in use in our plant, and with some more added to them.

As I said before, there are a great many things that we can each of us, as individuals, think, of, there are many things that we would like to see in there, possibly, but that wouldn't apply to somebody else's plants. Those things that have been questioned so far in connection with limit switches and repair men signaling the operator and the floor man signaling him at the same time, those are all things that we in our plant have rules to take care of. If anybody would be interested in those rules, I will be only too glad to give them a copy, or if you will write to our company, we will be only too glad to forward you a copy of them. I personally would like to see those rules adopted as they stand, and then, if anybody wants to add something to them, no doubt he can find any number of men in here who will be glad to tell him of some things that he can use in his plant that they are using in some other plants.

There is only one other thing that I think perhaps could be added to this aside from those that have been read that could be universally used, and should be, perhaps, and that is a set of illustrated signals.

Now, we don't make all of our own crane men, we don't teach and develop all of our own crane men; we would like to do that, that is the ideal situation, but we pretty generally throughout the country have gotten crane men from some other plants, and the set of signals, that is, those that are used in this country, at any rate, should be all one and the same. If I teach a man in my plant a certain set of signals and he leaves me, for the sake of safety I should have taught him the signals that are used throughout the country, not just a set of my own signals or signals that are used in our own plant, but signals that are used every place. We have a set of signals that are recommended by the National Safety Council, I believe, I am not entirely sure about that. Mr. Scott, isn't there a set of illustrated signals for crane men?

**Mr. Scott**: Yes.

I was under that impression. Those are the ones that we use. It is just possible there are some plants which do not have those. We have them. I will not say we have those, but we will, when our new book is published, have those illustrated in there so our floor men and our crane men will all be familiar with that set of signals. We use them at the present time and teach them to our crane men, but the floor men use pretty nearly any signal that they take a notion to use. If they can't think of a signal, they holler at them. That is one thing that I think could be added to that in the future.

**A. J. Standing**: "Floormen when signaling to the crane operator must use the approved crane signals, and above all, they must be sure that they do not confuse the operator." That rule attempted to cover the approved set of crane signals, which is the National Safety Code approved crane signal card, which I thought was in every plant in the country.

The second part of that rule was to avoid the question brought up of hollering at the crane men. "Above all, they must be sure that they do not confuse the operator."

Lots of accidents happen when superintendents and foremen, particularly in an emergency, take command of the situation and start hollering and sometimes cursing at the crane man over and above the normal man who is supposed to conduct the operation.

Another thing about these rules. In our review of various rules they ranged up as high as 52 rules. I don't think there is any crane man under the sun who is going to read and digest 52 individual rules. We tried to boil it down as well as we could to these 16 general rules which would direct his atten-

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tion during the period of operation only to certain predetermined functions that he should watch only when operating, with a view to leaving all these other 30 or 40 rules to be put in at the discretion of the managements of the various plants, we recommending only those that will save the operator of the crane.

**C. L. Baker:** Are there any further questions or remarks? The question being called for, I will put the motion for the adoption by this Association of the rules recommended by the special committee and recommended by the Board of Directors of the Association of Iron and Steel Electrical Engineers. All in favor of adopting these rules and recommending them to the Iron and Steel Industry will please say "Aye." Opposed and for amendments, "No." Gentlemen, the "Ayes" have it and it is so ordered.

I believe that the industry as a whole can very well take this, I may say, simple set of crane rules and around them build rules that will safely operate cranes in any plant in the iron and steel industry.

The safety engineers are always on the alert to further safety and this is especially true of those men in the iron and steel industry. This is your iron and steel engineering association, and the different activities will be just as strong as your support makes them. In other words, the different divisions cannot be strong and cannot accomplish things without the co-operation of every member.

If you have not already done so and do not have a copy of the Iron and Steel Engineer for the Month of June, I wish you would avail yourself of a copy while you are here at this meeting and read one article in this issue. The author is a safety man and he talked to you this afternoon. John Oartel is the author and he speaks of the Four C's and I would like all of you to know what those Four C's stand for. I think it well worth reading and remembering.

The attention and the interest that has been given in the meeting this afternoon has been beyond the fondest expectations of the Chairman, I assure you. While I knew from experience that the electrical engineers—and I am acquainted with quite a number of them—are what you would term "sold on safety," they have again today demonstrated beyond the shadow of a doubt their intense interest in the furtherance of safety in the iron and steel industry, and that is what we are all here to do—every member of this Association is for the advancement and the betterment of the iron and steel industry in this country.

I want to thank you gentlemen for the courtesy that you have shown the Chairman this afternoon. Your attention has been wonderful, your interest has been fine to every speaker and to everyone who had anything to say. This division is going on and is going to take up a subject at a time and endeavor to complete it. There is never any safety job, you may say, entirely completed, because of the changes in the industry, and particularly in the electrical phases of operations. You know what wonderful advancement has been made in the use of electricity in the iron and steel industry in the last ten years, and it seems that we have hardly started. I repeat, we are going to take up one or more subjects each year in the safety division and complete them in so far as possible.

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# *Discussion: Gas Producer Operation**

**H. C. Seibert†:** The gas producer subject is an old one with our friend Bill Chandler. Mr. Chandler, will you care to add something to the discussion?

**W. P. Chandler, Jr.‡:** I thing Mr. Leahy, in his paper, has struck a very vital note. People who have been used to working with gas producers and the labor that operates gas producers, time and again have gone into the gas house and said, "The gas is bad." The foreman says, "We are doing everything that we can to make it good; I don't think there is anything wrong here; it is back there, the furnace men don't know how to take care of the job of burning the gas." That is very often the cry. The man is trying to do his job and doesn't realize that he isn't getting across what he should be doing.

Mr. Leahy has brought out the fact that the instruments required to show the gas house operator when he is doing the job and how he can change it so he can do the job better, are the very things that are needed for the class of labor that we have in the gas house and for our gas house foreman, to give him a means of obtaining the end he wants.

It also reverts right back to the furnace efficiency and the better results in the furnaces using this gas. It is the thing to work to, it is the point to strive for, and it is a guide that will also be a perfect alibi if he has abided by it when the furnace man comes back and says that the gas isn't any good, he can point to his chart and prove his case. I think that is the biggest thing in the paper that Mr. Leahy has presented.

The place where the turbo-blower might have a superiority over the steam jet aspirating blower, is in the plant that is likely to get widely varying grades of coal from one time to another. Any aspiring blower of the steam jet type can be designed to give you what you want for a certain range of coal, but if you are going to get coal that has a temperature of ash fusion down around 1900 degrees at one time, one month, and then get a good grade of coal that will go up to 2400 degrees another month, the steam jet blower has a pretty hard job to cover it. The turbo-blower on the other hand, due to the fact that you introduce the amount of steam separately, can cover the job.

I think that when I read a paper on this subject a couple of years ago, I made a little broader statement than I should have. I do not know that steam

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jet blowers can be built for a rather wide range, but for a producer using all grades of fuel, you probably will have to have a separate control of your steam from your air.

**E. Trexler***: It would be interesting to know approximately what the savings were in pounds of coal per ton of steel in the furnace.

**M. J. Conway†**: I haven't very much to add to Mr. Leahy's paper, except to corroborate Mr. Leahy. He is to be congratulated on the novel comparison he has drawn in his paper between the quantity of fuel used at the steam plant and the quantity of fuel used at a gas producer plant.

In my opinion, gas producer operation in a large steel plant is no more a part of the duties of the superintendent of the department which they serve than the operation of a by-product plant should be under the supervision of the galvanizing shop superintendent because he happens to be using by-product gas as a fuel under the galvanizing pots.

Long ago we separated the boiler plant from the steel plant departmental supervision and made it a separate service department, and we are rapidly coming to the conclusion that the gas producer plants are a separate service department, demanding close supervision, which usually cannot be given or expected from the department for which they provide gaseous fuel.

At our Steubenville Plant we have a battery of six R. D. Woods producers fully mechanically operated serving seven blocks of 4-hole soaking pits of average size which have been operated since February, 1925, with recording flow meters, recording pyrometers and recording blast temperature recorders as integral apparatus with the producer as part of our gasification operation.

The importance of these instruments cannot be overestimated, and the gas producer manufacturers should make their inclusion a part of the installation quotation in the same way as the coke oven builders make the temperature and pressure recording instruments part of their quotation. The only privilege we, as purchasers, should have should be the choice of the make of these instruments for the purpose of standardizing our equipment where necessary.

In the past, many papers have been given on the operation of gas producers, many of which have been beneficial to you and I, but the point which we have failed to get over until today is a paper which would benefit the men who make the gas.

Get the gas maker to realize the importance and usefulness of these recording instruments and his work will not only be easier, but he will produce a better grade of gas at a much less cost than he would without the use of the instruments.

Fuel economy is a process of elimination of wastes and the first place to start is the gas house, and by the use of recording instruments at the gas house we can get nearer to the next point of waste, thereby saving a lot of time and money for our respective companies.

Our experience has been that the use of these instruments, or a more scientific control of the producer operations, cuts down to a great extent the laborious work connected with the old methods of making gas, and therefore attracts a better class of labor to the gas house, making supervision much easier.

**V. H. Carples***: Mr. Leahy makes the statement that he recognizes the advantages of a turbo-blower as giving separate control of air and steam, but he makes the further statement that its mechanical difficulties have prevented its rather general application. We have a number of blowers in operation in the steel mills with producers, in fact, I believe the one that Mr. Chandler's test work was based on, and I think this matter of mechanical difficulties and maintenance has been rather over-stressed.

The application of these blowers in steel mills for producer work is more recent, but the same type of blower is being used in boiler plants and it is no uncommon thing for these turbine blowers to operate for from four to six years without a single repair or replacement being required. I will grant that the boiler room is still somewhat cleaner than the producer house, but I believe that the service which these machines have given in boiler plants is pretty conclusive proof of their ability to stand up in producer plants.

In reference to the matter of first cost, I believe that the cost of turbine blower is not very greatly in excess of that of high grade steam jet blowers.

Referring also to an item touched on by Mr. Witting, he pointed out that in trying to use the amount of steam flowing with steam jet blowers as a measure of the amount of coal gasified, there is an error in that the conditions in the producer vary; so that the amount of **air** flowing for a given quantity of steam is not a constant. Here, again, the turbine blower, offering separate control of air and steam, overcomes the deficiency, in that it permits varying the air pressure with a constant **volume** of air without affecting the quantity of steam supplied.

Finally, referring to the matter of the greater use of instruments, it would seem possible by such instruments for observation of results, and with automatic devices for control, to use the turbine blower to get complete automatic operation. The primary regulation would be effected from the amount of gas flowing or gas pressure which would operate to control the steam supply to the turbine blower, in other words control the amount of coal being gasified, the secondary control being the thermostatic regulation of the steam needed to maintain the desired saturation.

**D. M. Spitzglass†**: I read Mr. Leahy's paper once very carefully and then I read it over again. In doing this I endeavored to find something that I could disagree with Mr. Leahy on. When I read a paper, I always like to look at the face of one who agrees with me. It makes it more pleasant. But when I get through with the reading, I like to hear from one who disagrees with me, because then something may be brought out. If he disagrees and doesn't say it, he will never be convinced.

Now, in what could I disagree with Mr. Leahy? I couldn't very well afford to say that instruments are not necessary. I tried to disagree with him on his enthusiasm about the boiler plants. From read-

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ing his paper one might get the impression that every boiler plant is equipped with all the instruments necessary. Well, I could disagree with him on that, but then, I found a weak point in that, too. They are at least ten times more equipped than the producer plants, so there I have no argument again.

The only thing I can do is to mention one point which I believe should be brought out more forcibly, and that is the difference between the producer and the boiler. Even if you have a dozen neighbors who don't care to know the conditions of the boiler, still, don't follow their example, because you are much worse off in the producer.

Mr. Leahy states that the faulty operation of the gas producer may seriously impair the quality an quantity of the product. I hope he means quality and quantity of the product of the furnace, then they will all come and stand in line to ask for instruments. You see the difference is this. You run a boiler plant and, as many big men will say, "Well, we have to make as much steam as we need. What can we do? We have to fire the boilers until we have sufficient steam to keep the pressure up. What is the difference whether you know how much it is or not?"

The reason is, if they run a steel plant and, assuming that the operator does not know the temperature of the process, he may spoil a whole batch of steel. At that point they don't want to guess. But in the case of the boiler the steam is just of the same quality and it can do the same kind of work, whether it has obtained five pounds of steam per pound of coal or eight ponds of steam per pound of coal, no one will know the difference; they cannot resognize it in the steam; they can very well recognize it in the steel. So I hope that Mr. Leahy meant that it is the product of the furnace and not the product of the producer, because if it is the product of the producer, it will take them a long while to realize that.

One more word. If you want to follow some one, I believe that those who want to know conditions more in the line of generating power are really the accounting engineers. Modern practice is to first obtain metering equipment for the distribution lines, so there isn't a cent lost between one department and the other. Very often they leave the boiler to the very end.

**W. R. Culbertson***: I really am not prepared for much of a discussion. I have thought this matter over some and talked it over and we would like very much to see more gauges and instrument boards used. If we could, we would very gladly equip every producer that is put out with an instrument board, complete. Our main drawback to that has been the competition in prices, etc The purchasing agent as a rule wants to buy the piece of equipment at the lowest possible figure, and he will oftentimes eliminate everything but the producer, he won't even have the motors come with it. If we could all get together, the producer manufacturers, and standardize on a certain board and insist on that being a part of the producer. I think it would be a step in the right direction and it wouldn't be long until all the older producers that are now operating would be so equipped. As I look at it, it is probably a matter of five to eight hundred dollars to completely equip a producer with instruments, and when you figure the amount of coal that that producer is using, it is only a few months before it would pay for itself. I should judge that in most of the large plants that are using producers the gas producer house consumes probably three-fourths of the total coal used and the boiler house probably the other quarter, especially is that true of some of the larger steel plants and glass plants. The boiler house is equipped with every instrument imaginable and the producer house is not. We are very willing and would be glad to include instruments as part of our equipment and insist that they be furnished with every producer if we could get the co-operation of the men buying them.

**A. G. Witting***: Mr. Chairman, I would like to ask a question. Mr. Leahy says that the coal and gas supplied is in proportion to the steam used. Now, if you have a bank of three or four producers to a furnace operated with steam jet blowers, each one of them is taking a different amount of air at all times while the amount of steam is equal for all of them. How can it then be possible to claim that the amount of coal gasified is directly proportional to the steam, as the ratio of steam to air is always different for each producer and variable in proportion to the back pressure?

It is certainly extremely important, as Mr. Leahy points out, to cut down the steam to a minimum. I think that with an ordinary but properly designed steam jet blower it will be possible to get a satisfactory proportion of steam to air—we have secured blast temperatures as low as 115° Fahr. indicating a low steam ratio, and I think we will in time get even lower temperatures. As everybody knows, the lower the steam amount, the better, as long as clinkering does not occur.

Incidentally, I recently heard about a new type of producer that will appear in the market, where steam is not used at all but evaporated water. The air is delivered to the producer by an individual blower which sucks the air over and around the water-cooled surfaces of the producer, thereby heating the air which absorbs a certain amount of moisture out of the water used for cooling. Whether that is practically possible I don't know, but there certainly would be a very decided saving if you thus could eliminate the steam used to prevent clinkering. If, for example, you use .3 pounds of steam per pound of coal and you gasify between 4,000 and 5,000 pounds ofcoal per furnace per hour, you are using 40 to 50 boiler horse power of steam. And if you can eliminate this steam by absorbing the necessary moisture from the cooling water, you will affect a considerable saving in operating costs.

I decidedly agree with Mr. Leahy that automatic control and the use of recording instruments to tell the performance are very much necessary. I cannot over-emphasize the necessity and the value of having a chart to tell the men about their method of operation. They cannot deny the record on the chart, even though they can deny everything else.

There are many other points in Mr. Leahy's paper that deserve deep consideration and could call forth fruitful discussion, but, as I said before, I have been so busy that I have, unfortunately, not had the time to read through and absorb this very interesting paper, and, consequently, I cannot go into any fur-

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ther discussion. I hope somebody else has been more fortunate in this respect.

**W. B. Chapman***: Mr. Chairman, I want to say a word of appreciation of the paper, because it puts the emphasis just where it belongs, on knowing more about what we are doing. I think that is the chief fault of us gas producer people, we haven't known over much about what's going on in the fire bed.

One reason why we haven't known, is because the producer gas house is usually too dirty for data. If it were a cleaner place, such as the boiler house or the engine room, more instruments would be used and more accurate observations made. Then, again, if the gas house were cleaner, the manager would sometimes come and see the place where he is wasting the largest amount of the company's money.. In purchasing a producer, one should have in mind not only the amount of gas it will make, but the amount of smoke it will emit.

Another point I would like to add to the paper is in regard to the variation in quality and quantity of the gas due to the soot that accumulates in the flues. It is common practice, though wrong, to shut down once a week and clean the flues. Flues should be cleaned every day, and the plant should never be stopped a minute for cleaning. Daily cleaning without stopping is now being accomplished in open hearth plants and in chemical works. It is merely a matter of coming up to date and learning how.

Special nozzles or connections can be installed every little ways in the flues for blowing the soot along in the direction that the gas flows. The blowing is done right while the gas is flowing through to the furnace. The soot partly burns in the flues and partly in the furnace without interrupting normal operation. It is being done right here in Chicago at both Open Hearth plants of the Illinois Steel Co.

Another thing we really ought to have in mind in gas producer operation—and also in purchasing a gas producer—is a more definite idea about what the fire bed should be. We seldom have a concrete picture of the ideal we are aiming at. Any horizontal zone straight across the fire bed, whether it is across the top or the center or the bottom should be a uniform zone, both in density and temperature. The nearer uniform you can make a zone in density and temperature the nearer you will approach ideal conditions. Then, having secured some approximation of horizontal uniformity, use the instruments for maintaining that uniformity. As long as you have a horizontal zone that varies in density—a blowhole in one place, a clinker in another, a high temperature in one spot and a low temperature in another—it is impossible, with all the instruments in the world, to get anywhere.

In judging any equipment, one should have in mind, "Is it possible with this equipment to get more nearly uniform conditions across each horizontal plane in the fire bed?"

The direction of progress for the immediate future, I believe, is in the direction of greater uniformity of fire bed conditions, indicated and maintained by suitable recording instrument.

To use gas economically, it must be kept at uniform pressure in the gas main and must be of uniform thermal value, also of uniform temperature To make gas economically—and that's different from using it economically—the hot zone of the fire bed should be maintained as hot as possible and every portion of the fire bed should be kept as uniform as possible. Keep in mind uniformity and it will ultimately lead you to the solution of your problems.

**F. E. Leahy***: We didn't want to get into any discussion on the auxiliaries or parts of the producers, but rather we are trying to confine it to such discussion that will help the producers more in their daily operation.

About the use of the steam flow meter to estimate the fuel, that depends on the operation, first you have got to maintain the conditions that have been outlined, constant with the instruments, then your flow meter does become a measure of the fuel. For a given fuel, answering Mr. Spitzglass at the same time, one coal you might be able to gasify with .4 of a pound of steam, another coal it might take to get continuity of operation .6 pound of steam per pound of coal. In one case your ratio would be .4 to a pound of steam per pound of coal; in the next case, .6, but with the meter in both cases, by applying the correct factor, you can estimate the amount of fuel. We have been using that method for some time. The first thing is to determine the multiplier by getting the monthly readings of the steam used and the coal used.

Mr. Trexler asked about the increased production due to control. On one turn of a department there was an improvement of about 12 per cent, through knowing that that department was not working the furnaces up to capacity, which information was taken from the flow meter, and by changing the practice and bringing the two turns close up together, we got very close to the same production.

Another thing The uniformity and the quality of our product was maintained better under control, because it is possible to locate the cause of trouble.

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*Plant Engr., Pittsburgh Works, National Tube Co.

IRON AND STEEL EXPOSITION

JUNE, 1927

PITTSBURGH, PA.

# "Good Order As An Essential For Safety"*

By J. A. VOSS†

"A place for everything and everything in its place," and "Cleanliness is next to Godliness," are old slogans that can well be applied to the subject assigned to me, entitled, "Good Order as an Essential for Safety." In my opinion good order or good housekeeping is as essential to safety as is safeguarding, bulletin boards, safety rules, safety education, etc., and if we are to carry the safety movement to its highest point of efficiency we must, of course, first teach the workmen the A, B, C of safety, which spells "Always Be Careful," and then follow up this education by teaching them the A, B, C of good order, which spells "Always Be Clean."

Our accident statistics show that from 8 per cent to 10 per cent of accidents are due to workmen slipping, tripping and stumbling, and that approximately another 12 per cent are due to men being struck by falling material. Accidents applicable to disorderliness might be grouped as follows: Stepping on or over objects lying on floors; piles of material falling over; greasy floors; wet floors; fruit peelings, etc. Such accidents emphasize the necessity of good order and good housekeeping, and it is, therefore, highly important that orderliness be made a permanent part of the safety program.

Then, also, there is disorderliness in person; workmen have loose ties, loose sleeves, jumpers, and other clothing which get caught in machinery and serious injury is usually the result of such neglect of workmen. Orderly, clean plants produce orderly, clean and more satisfied workers. More than that, an orderly, clean plant with clean surroundings will influence the betterment of workers' habits and this influence undoubtedly will extend to their homes, thus benefiting their families. There is no doubt of the fact that disorderliness and uncleanliness not only cause accidents, but sickness, misery and unhappiness. Bad housekeeping, in addition to causing many accidental injuries, is also responsible for starting and spreading many fires, with their accompanying enormous loss of property and sometimes of life.

Clean, orderly conditions are pleasing to the eye, contribute to the health and produce happiness and contentment amongst employes, and it is a splendid advertisement for product, management and workmen. It creates that first impression at first sight. Good housekeeping is a good sign of good management and good workers.

In many cases good housekeeping, besides preventing accidents and fires, will save space, time and material. This is particularly true with reference to the piling and storage of material. For instance, if castings, tools, spares, etc., are thrown on the floor in a heap, they take up considerable more space than if they were arranged in piles or stored in bins or racks. Moreover, it takes longer to sort or count them, or to make a selection; and the number of parts broken or damaged is likely to be much greater. It is, therefore, obvious that good order and good housekeeping means money to your company and that the financial saving is in proportion to the seriousness of the accidents or fires prevented, and to the value of the space, time and material saved. In a similar way it can be shown that good housekeeping means more efficient operation and a greater production.

Realizing the importance of good order and good housekeeping as an essential for safety, a cleaner plant and greater efficiency, the management of our company appointed on April 1, 1925, a Plant Clean-Up Committee to formulate a plan that would overcome disorderliness and that would keep our plant clean at all times. At the outset the committee adopted a slogan: "Our Aim—A Clean Plant Always."

The Clean-Up Committee is made up of Superintendents representative of our entire operation, viz: Safety Director, Chairman; Superintendent Central Division, Superintendent Sheet Division, Superintendent National Division, Superintendent Mechanical and Electrical Departments and Fire Chief.

Meetings of this Committee were held and the first thought of the Committee was to develop a plant that would reach every workman in the plant. It was then decided to have cards printed and numbered, as per the following:

The Central Steel Company, Massillon, Ohio.

PLANT CLEANLINESS CONTEST

Our Aim—A Clean Plant At All Times

This card will entitle you to a chance on prizes to be awarded to the five departments kept the cleanest during the months of April, May, June, July, August and September. The prizes will be awarded monthly, viz:

Department in first place, $60.00 Suit.
Department in second place, $12.00 Shoes.
Department in third place, $8.00 Hat.
Department in fourth place, $6.00 Shirt.
Department in fifth place, $4.50 Socks.

It is necessary that you are in the employ of the Company at the time that the prizes are awarded, otherwise you are not eligible to participate in the contest. Prizes will be awarded May 1, June 1, July 1, August 1, September 1 and October 1, 1926. Retain this card as you will need same for identification in the event your number is drawn.

We need your help in order to keep the Plant clean and you should see that your place of work and the surrounding premises are kept free from food scraps, oily waste, paper, rubbish of all kinds, markings on buildings and equipment, etc. Piling of material, orderliness, appearance of machinery, equipment and buildings are also essentials in Plant Cleanliness.

Can we count on your support?

Committee.

*Presented at Cleveland District Sections Safety conference, May 5, 1926.

†Safety Director, The Central Steel Company, Massillon, O.

This card is self explanatory. Every employee is given one of these cards, same being distributed through the departmental superintendents. The employee's name, check number and occupation are placed on the stub and the stub returned to the Chairman of the Committee. At the beginning new cards were issued quarterly, but recently we decided to reissue the cards every six months. Further publicity of the scheme was given in our plant publication, "The Agathon News."

The Clean-Up Committee makes a monthly inspection tour of the plant which requires approximately two days and inspects every building, every floor in every building, and every room on every floor, as well as the yards and offices. Not only matters of orderliness are sought, but also things tending to the betterment of hygienic conditions, fire prevention and safety.

A stenographer accompanies the Committee on the inspection tour and takes note of all recommendations made by the members of the Committee. After the inspection tour is completed he immediately issues an individual Clean-Up Order, as per exhibit shown below, for each disorderly or uncleanly condition:

Form W-1501

Our Aim—A Clean Plant At All Times

The Central Steel Company, Massillon, Ohio

.....192... No.....

Mr..... Supt..... Dept.

The Plant Cleanliness Committee charged your department with a demerit on account of the following condition: .....

.....Chairman

You are allowed one week to correct the above condition and for the return of this order to the Chairman.

Chairman-Plant Cleanliness Committee.
The above condition was corrected on

.....192...

.....Supt.

After the Clean-Up order is issued these matters are taken up at once by the respective Superintendents and necessary action taken to correct same.

After three inspection trips had been made the Committee decided to formulate a set of rules which would constitute demerits in the Plant Clean-Up Campaign, which are as follows:

The following Conditions shall constitute Demerits in the Plant Clean-Up Campaign:

1. Unnecessary writing, printing, marking, etc., on lockers, cupboards, machinery, buildings, equipment, etc.

2. Old clothes, gloves, refuse, etc., on top or underneath lockers.

3. Food scraps, paper, bottles, old waste, etc., on floor or ground instead of in litter boxes.

4. Buildings allowed to become unsightly due to lack of necessary repairs or upkeep.

5. Material in process or to be processed if not kept in an orderly manner.

6. Ingots improperly piled in Mill Buildings or in Yards.

7. Piles of scrap, refuse, dirt, obsolete material, etc., inside or outside of buildings.

8. Dirty floors and walls of offices and toilet rooms, also unclean toilet fixtures.

9. Cord wood, ties and lumber scattered about the plant and not piled properly.

10. Dirty footwalks on stairways.

11. Castings, spares, oil barrels, reels, oxygen tanks, etc., scattered about the plant instead of place provided for same.

12. Material such as window frames, loose sheet iron, wooden blocks, old gloves, waste, etc., on roof of buildings and furnaces.

13. Any uncleanly condition not applicable to work being done.

14. Any uncleanly condition resulting from a job completed.

Later these rules were published in our plant magazine. The Clean-Up Committee in making monthly inspections is governed entirely by these rules and any violations of same constitute demerits in that department. The total number of demerits divided by the average number of men employed per day gives us the percentage of disorderly and uncleanly conditions. This percentage subtracted from 100 per cent gives us the standing of the various departments. The departments are then ranked according to the highest percentages. I might say at this time that whenever the Committee finds a condition which is not governed by the rules of demerits, a Clean-Up order is sent out, nevertheless, stating that the condition is not a demerit but a recommendation made by the Committee. In the event that the recommendation is not carried out by the following inspection or the time allowed by the Committee, it develops into a demerit. The department is given time from one inspection to the other to clean up any and all demerits, but in the event that the Clean-Up order is not returned before the following inspection and if the demerit is not corrected, another Clean-Up order is sent out and two demerits charged against that department. A report showing the standing of the departments in the Clean-Up Campaign (as per copy shown below) is furnished all department heads at their weekly operating meeting and discussed. These reports are also posted on the plant bulletin boards.

STANDING OF DEPARTMENTS IN THE PLANT CLEAN-UP CAMPAIGN

Month of April, 1926

| Rank | Departments | No. of Demerits | Percentage |
|---|---|---|---|
| 1 | Sheet Mill Hot Mill | 13 | 96.50 |
| 2 | Sheet Mill Finishing | 11 | 94.86 |
| 3 | National Division | 13 | 94.78 |
| 4 | Heat Treat | 6 | 94.64 |
| 5 | Labor and Transportation | 7 | 93.75 |
| | Labor | 4 | |
| | Transportation | 3 | |
| 6 | Billet Sheds | 31 | 93.60 |
| 7 | Bloom and 24" Mill | 11 | 92.76 |
| 8 | Open Hearth | 29 | 90.99 |
| 9 | 12" and 18" Mills | 29 | 87.39 |

| | | | |
|---|---|---|---|
| 10 | Mechanical and Electrical | 42 | 86.32 |
| | Mechanical | 25 | |
| | Electrical | 17 | |
| 11 | Miscellaneous | 27 | 82.69 |
| | Pattern Shop | 1 | |
| | Fire Dept. | 2 | |
| | Mason | 2 | |
| | Construction | 1 | |
| | Mill Office | 10 | |
| | Stores | 7 | |
| | Time Office | 4 | |
| Total Demerits for April | | 219 | |
| Total Demerits for March | | 113 | |
| Increase | | 106 | |

A board showing the standing of the departments is kept in the meeting room continually and a similar board is also kept in each division where it can be seen daily by every workman.

After the Clean-Up orders are sent out and the final figures completed we immediately proceed to award the prizes in the five departments at the top of the list. The stubs from the cards are kept in separate containers according to the departments and these stubs are taken to the five departments having the highest percentages and a drawing is made in each department by the workmen themselves, the first number drawn winning the prize. The drawing for the prizes in this manner eliminates any and all questions of doubt and is also another medium of keeping the campaign stimulated and the workmen interested.

In orderliness and good housekeeping it is necessary to develop a system to be followed in the same manner as a system that is followed by an efficient safety organization, and such a system as has been adopted by our company and which has proven itself very successful no doubt will be gradually improved and adjusted to actual needs. We feel that during the past year a great deal of good has been accomplished along these lines, and inasmuch as we replace the cards periodically we feel that every workman is now fully familiar as to what is required of him in his daily work to help keep his place of work clean and orderly. This campaign has taught us the mutual advantage of employer and employee, has been very educational to the workers, and they individually make efforts to keep their place clean and orderly. In nearly every instance when an employee learns of a disorderly or uncleanly condition he hastens to correct it. Many improvements have been made to develop orderliness in our plant along the lines of providing racks for spares, rolls, tools, etc., proper disposal of food scraps and other refuse, material kept from top and underneath lockers, markings removed from buildings, machinery and equipment, and many other improvements too numerous to mention.

We have adopted a slogan, "Our Aim—A Clean Plant Always," and we feel that we are gradually reaching the goal of our aim. Just before writing my address on this subject I talked with our Superintendent of Labor Department and he informed me that instead of placing a large number of men to work at spring house cleaning that our spring house cleaning is done, and that we not only have a clean plant for a few months of the year, but that it is kept clean and orderly the entire year. He also informed me that since this campaign was started that men have learned to keep their departments clean, which eliminated the necessity of a gang of men following them up to remove dirt left behind them. His force of clean-up men has been materially reduced and the cost for this work has been reduced in proportion. I am merely giving you these figures to show the economic waste of material and labor which can be eliminated by an efficient campaign for good order.

Safety engineering or accident prevention work is on record as an advocate of close working relations and this work has allied itself with many other units, one of which is orderliness. Today orderliness makes a strong appeal, not only to the appearance of the plant, but makes its strongest appeal when it bids foremost to the saving of human life and limb. A fight for orderliness is a fight for greater safety, less fires, better working conditions, more and better production, better sanitation, elimination of waste and a clean plant at all times. The cleaner and more orderly a plant is kept the greater asset it is to any company. The plant that is kept orderly will attract and hold a better class of workmen and will eliminate those who do not feel at home in a clean and orderly atmosphere which is a great factor in the reduction of accidents. In conclusion, gentlement, Order is an Essential for Safety. It means an orderly plant which spells a safe plant and which in turn means greater efficiency. Finally you will find a great saving in dollars and cents and above all it is a great stride forward to conserve human life and limb and experience has proven to us that its influence will extend far beyond our immediate sphere.

# *Discussion on Steel Mill Yard Electrification*

By DAVID C. HERSHBERGER*

THE steam motive power in use around steel plants has been built up over a long period of years and is surrounded by conditions favorable to this type of power. Any system used to supplant it must insure improvement in such factors as reliability and economy, particularly the latter. A system which may successfully supplant these steam locomotives must show marked economy over the steam locomotive.

The electric locomotive has also been in service a relatively long period of time principally in steam road and interurban railway service. It has also been employed in more or less isolated applications throughout the various steel plants where a particular service over limited trackage is to be performed. In this service the electric locomotive has been emi-

*General Engineering Dept., Westinghouse Electric & Mfg. Co.

nently successful. In the past the performance of electric motive power has been so eminently satisfactory that it is taking the place of steam motive power. Its economies are such that it is expected that the rate at which it has been supplanting steam will be increased. The economies of this type of motive power are assured and have been substantiated over a period of years so that there is no question as to the application of the third rail type locomotive. This study shows that in the operation of supplanting steam, the economy is at least 16 per cent exclusive of interest and depreciation charges on steam locomotives but applying these charges to the new electrical equipment. In new installations where new motive power either steam or electric must be purchased, the conditions are even more favorable to the electric locomotive, in which case the saving would be approximately 24 per cent.

It is a satisfaction to know that the various isolated installations now being put in are at 250 volts D.C. Later it will be found that the electrification of the various sections of the steel plants can be consolidated and the complete electrification consummated without extraordinary expense. This is made possible only by the holding to a definite voltage at this time as explained in the paper on "Economies of Steel Plant Railroad Electrification."

At this time it would appear that a combination type locomotive is a necessity in part of the service; and for this service it is comparatively clear that a combination third-rail type and storage battery type locomotive is the most applicable, i. e., a locomotive which would normally receive its power from the third rail, but would also carry a battery which would be charged from the third rail, and which would operatethe locomotive on sections where it is not feasible to install third rail. The changeover from third rail operation to battery operation or vice verse is so convenient that it is to be preferred.

The above paper discusses three different types of motive power, namely, Steam, Diesel-electric, and Electric. While the steam motive power has been a good servant, it seems to be destined to join the obsolete class on account of its high operating expenses and because of its other disadvantages such as time out of service, smoke-nuisance, etc.

The Diesel-electric locomotive, which is very much in the forefront at the present time, is relatively new and possesses some good characteristics such as great cruising range and economy in fuel. As to cruising range or in other words, having an advantage as an independent operating unit, this is not so essential, as the operations of a locomotive around a steel plant are limited to definite tracks which can be equipped with third rail and electrics employed. In the future it is expected that the price of crude oil will increase so that this factor must be considered.

The electric locomotive is the most reliable and economical unit as attested to by various speakers at this meeting. Its serviceability factor is very high. It may be kept in service practically all the time, particularly if a proper stock of spare parts are carried so that repairs can be made quickly when they are necessary, which is rather infrequent. The electric locomotive is a rugged unit. The requirements of steel mill service either within the mill or around the mill are such as to make it necessary to have rugged motors or propelling units such as only the electric motor provides.

Where the trackage per locomotive is very high and where third rail construction or overhead trolley cannot be installed, there is then sufficient reason for considering other forms of motive power.

The idea of the paper by Mr. Needham and the writer is that of crystallizing the ideas on plant yard electrification so that this work can proceed without fear of the equipment becoming obsolete in a short period of time. To this end the 250 D.C. system is recommended for the power supply. The third rail under-running type is recommended as the conducting system and after these two parts of the electrification have been decided it follows as a necessity that the 250 volt D.C. locomotive must be used, either as a straight locomotive or as a combination battery and third type.

Our company has recently sold to the Carnegie Steel Company an 80-ton locomotive for use in their Edgar Thomson Plant at Braddock, Pa. This locomotive will be used on a run approximately one-half mile in length mostly over elevated track hauling hot metal from the "bull pen" to the "mixer building." The cars are gathered from the various blast furnaces and made up into trains at the "bull pen" and will be hauled from this point to the mixer building by the new lomotive. This locomotive will receive its power from two under-running third rails. The 250 volt system at the Edgar Thomson plant is not grounded, so that it is necessary to have two under-running rails from which the current will be collected by two under-running shoes at each corner of the locomotive. The locomotive will carry a total of eight shoes to facilitate taking current from either side of the engine.

The trend of steel mill yard electrification is, we believe, progressing in the proper direction, namely that of electrifying the isolated sections of the steel plant and later going ahead with the electrification of sections of what might be called the "exterior system," eventually completing the entire program of electrification of all tracks about the steel mills.

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## EDUCATION AND SAFETY

(Continued from Page III.)

It is agreed that an educated man, woman or child will perhaps exercise a greater degree of precaution towards self preservation than those unfortunates who have not had the opportunity of acquiring accumulated knowledge.

If education offers the solution to the problems of Safety then it would seem that industry, in order to succeessfully cope with this problem, should seek for its fields of labor those who are among the eight hundred thousand or more who are attending the Universities and Colleges today in this country.

Under this plan many of the millions that are now being spent in educating the worker in the art of self preservation not only to himself but to his co-worker, could be diverted to other channels in industry.

Unfortunately for the human race and particularly for the Iron and Steel Industry it is not practical nor is it possible to take advantage of this plan and it is therefore necessary to stimulate the vast majority of workers in this industry to a greater effort in the direction of methods which will protect him from injury.

These methods must not necessarily consist of rules, rules that forbid this and forbid that but must be well defined and carefully thought out plans, which fit and are closely related into the workers every day routine.

Years ago industry was concerned with one purpose only, educating the worker to produce, however, today industry is concerned with man's welfare and we have only to review the United States Steel Corporation bulletin, number eleven, to find that this corporation has succeeded in welding together a prosperous, happy contented family; welded together not with rods of iron or steel, but with the milk of human kindness liberally distributed through out each and all of its respective plants.

Education for the workers, yes, but make your education more than high sounding phrases, let your education consists of sound basic plans and methods, which will enlighten your workers, methods which will produce contented workmen, methods which will produce prosperous workmen, methods which will produce skilled workmen. These three will give you what you are aspiring for "A Safe Workman."

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# *Tests of Arc Welded Structural Steel*

By A. M. CANDY* and G. D. FISH†

THE series of test specimens which are described and discussed in this article were all welded with the various members located in the same position and manner as would be required if the various members were actually a part of a building structure. As a result, all of the welds made were, therefore, executed from the same directions and were located in the same position as will be found in actual practice. For example, to weld the web of a beam to a column required welding along a vertical direction. To weld the under side of the top flange and the bottom face of the bottom flange of an I-beam to a column required the operator to execute overhead welds. For such operations as welding seat angles to columns and welding web plates to the web inside faces of the flanges of columns, the column sections were turned so as to permit the operator to make practically all such welds in the downward position due to the fact that in actual fabricating work these welds would be executed in the shop where it would be not only permissible, but advisable to turn the material in such positions as to make the welding most easily executed by the operator, and thereby obtain welds which would be thoroughly dependable. All joints made with a single bead of metal were executed so as to make the bead of metal approximately 5/16 in. in thickness at the center of the bead, and to extend out from the corner of the members so joined, a distance of approximately 5/16 in.

All specimens were loaded by means of rocker blocks 5 in. wide 8" long, 10" high finished on two faces to a radius of approximately 2 ft. Plates 1½ in thick, 5 in. wide by 8 in. long were placed between the rocker blocks and the specimen so as to distribute the load through the rocker block over an area 5 in. wide across the specimen. Cantilever specimens, of course, were loaded at a point approximately 3 in. from the end, whereas simple beam specimens were supported by means of the rocker blocks on various spans, as indicated by the sketches, the load being applied at the center of the specimen through a similar 5 in. wide by 1½ in. thick block.

The amount of weld metal used to make the various joints is unquestionably in excess of that actually required to produce joints of 100 per cent strength, but this was intentionally incorporated in the design of the test specimens so that we could prove beyond the shadow of a doubt that structural members can be joined by arc welding, making joints which will not fail even up to rupturing loads on the members so joined.

In carrying out further tests in the future, determinations will be made as to the minimum amount of weld metal which can be used for such joints and still retain the requisite strength at the joints.

By perusal of the data which are given in this article it is manifest that the tests fully demonstrate the following facts:

1. The tests demonstrate that welded joints can be constructed in such manner as to develop fully the ultimate strength of the structural members connected.

2. Beams and girders can be connected to columns so as to produce absolute fixation.

3. Lines of beams or girders can be connected so as to provide complete continuity across the supports, whether the supports be girders or columns.

4. That a steel I-beam of given section and length will sustain a far greater load if fixed at its ends by a suitably designed welded joint than if supported by standard riveted connections consisting of top and bottom angles. A 9 in. standard I-beam framed between rigid upright columns 8 feet apart by means of specially designed welded connections sustained a load 25 per cent greater than a beam of the same size and length framed between columns by means of riveted top and bottom angles of 1½ in. thickness.

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5. A plate girder assembled by welding and consisting of nothing but sheared plates, has a far greater bending strength than a riveted plate-and-angle girder of the same weight, due to the better distribution of the steel in the cross section. A 15 in. plate girder assembled by welding and simply supported on a 14 ft. span developed more than 50 per cent greater strength than a riveted plate-and-angle girder of the same depth and the same weight.

6. A double angle tension member such as is used in trusses was connected at the ends by welding, and when tested to tension failure broke through the angles at a load 30 per cent greater than the load at which a hanger consisting of the same size angles with riveted end connections failed.

The prevailing impression among the witnesses was that these tests demonstrated the superiority of welded connections to riveted connections in every case where direct comparisons were made, and brought out two general facts:

1. That complete continuity of lines of beams can be obtained in welded construction, whereas it is well known that this cannot be done in riveted construction.

2. That in a welded building it will be possible to make every joint develop full strength of the main members, whereas in a riveted building many joints are weaker than the members due to the weakening effects of the rivet holes and the weakness of steel angles which have to be used for transmitting tension between two members at right angles to each other.

It was proved that a welded plate girder was 50 per cent stronger than the riveted girder of relative depth, length and weight.

An Olsen testing machine, capable of applying 400,000 pounds, was used.

The tests proved the entire practicability of welding without any misgivings as to safety.

The joints that were demonstrated here are being used in the five-story steel building 70 x 220 ft., 80 ft. high, now being fabricated and erected by the American Bridge Company for the Sharon Works of the Westinghouse Electric and Manufacturing Company. The typical beam and girder connections are fully continuous connections thereby permitting large percentage of saving in the weight of the beams and girders to carry a given load. The same type of connection which develops continuity also effectively stiffens the building against wind. The equivalent cannot be obtained by any known riveted joint.

When the steel for the Sharon building is all erected steps will be taken to have the building codes of the larger cities amended in order to recognize welding under suitable specifications.

**Test No. 1**

Was a double cantilever specimen comprising cantilever I-beams "A" weighing 21 8/10 lbs. to the foot. 3 ft. long, secured to the column B which is an 8 in. H. section weighing 32 lbs. to the foot, 2 ft. long. Seat angles D comprising 4 in. x 3 in. x ⅜ in angles, 5 in. long, were welded to the column faces on which the beams "A" were landed, after which the entire end of the beams "A" were welded to the column faces. The edges of the bottom flanges of beams "A" were also welded to the seat angles D. After completing the weld between the top flanges of beams "A" to the column, plates C 4 in. x 7/16 in. x 5 in. long were placed in position and welded to the column face. Due to the fact that plates C are wider than the top flanges of beams "A" it was necessary to make overhead welds along the edges of the top flanges to the under surface of plates C.

The web plates E are 3 in. x ⅝ in. x 6⅝ in. long, four of which were used; two on each side of the column as indicated. These web plates were cut so as to provide approximately 3/16 in. gap between their ends and the inside faces of the column flanges. These plates were securely welded at their ends to the inside faces of the column flanges and were located directly in line with the top and bottom flanges of beams "A."

This test demonstrated several facts:

1st. That properly designed joints between beams and columns can be executed by arc welding so that the resulting joint is a great deal stronger than the members so joined. Such a joint is not only stronger but much more rigid than any similar joint could be made by riveting practice, due principally to the use of web plates E which give the identical effect of the beams "A" being continuous through the column.

The total weight of the complete specimen was 224 lbs.; 6 lbs. of welding wire was required and the time to make the specimen was 4 hours. The span for loading this specimen was 6 ft. 2¾ in. The yield point of this specimen was 50,000 lbs. and the ultimate load was 75,100 lbs. Failure by web crippling of beams. Ultimate bending moment at column face 125,000 inch-pounds.

**Test No. 2**

Was a specimen similar to No. 1, the difference being that the beams "A" are 9 in. Bethlehem I section weighing 20½ lbs. to the foot; plates C are 4 in. x ½ in. x 4½ in.; seat angles D are 6½ in. long. In this case the welding procedure was exactly the same as described for No. 1 with the single exception: The plates C being narrower than the top flanges of beams "A" it was possible to weld downward when securing the edges of plates C to the top face of the flanges of beams "A."

This specimen demonstrated the same facts as pointed out for the first specimen.

The complete weight of this specimen was 211 lbs. 8 oz. The amount of welding wire used was 5 lbs. 12 oz. and the total time required to weld the specimen 2 hrs. 35 min. The span for loading this specimen was 6 ft. 2½ in. The yield point of this specimen was 57,000 lbs. and the ultimate load was 70,000 lbs. Failure by web crippling of beams. Ultimate bending moment at column face 116,500 inch-pounds.

**Test No. 3**

This test was very similar to the preceding specimen, the difference being that seat angles D and plates C were omitted; the beams "A" were welded directly to the column faces entirely around their ends without any means provided for landing or any re-enforcement provided other than the weld metal itself.

This specimen weighs 198 lbs. 8 oz. The amount of welding wire used was 4 lbs. 9 oz. and the total welding time was 2 hrs. 20 min. The span for the loading on this specimen was 6 ft. 1¾ in. The yield point for this specimen was 50,000 lbs. and the ultimate load was 60,000 lbs. Failure by web crippling of beams. Ultimate bending moment at face of column 99,000 inch-pounds.

These loads are lower than the loads obtained on specimen Nos. 1 and 2 which is attributed to the fact that the omission of landing brackets D and the re-enforcing plates C reduces the stiffening produced in the flanges of the beams "A" which is obtained where these parts were used in specimen 1 and 2.

**Test No. 4**

This specimen is to be directly compared with specimen No. 2, the only and vital point of difference being that web plates E were omitted. The test on this specimen demonstrated very clearly the greatly increased strength and rigidity of specimen No. 2 which employed the use of the web plates E.

The total weight of this specimen is 199 lbs., there being 3 lbs. 8 oz. of welding wire used. The time required for welding was 2 hrs. 15 min. The span for loading this specimen was 6 fet. 2½ in. The yield point for this specimen was 28,000 lbs. and the ultimate load was 50,000 lbs. which is to be compared with the yield point of 57,000 lbs. and ultimate load of 70,000 lbs. for test No. 2. Failure took place by buckling of web of column between beams in specimen number 4. Ultimate bending moment at face of column 83,000 inch-pounds.

**Test No. 5**

Test No. 5 was also a double cantilever specimen made up of the following members: Two beams "A" comprising 8 in. H-beams weighing 32.6 lbs. to the foot, 4 ft. long; one column B comprising a 10 in. H section weighing 49½ lbs. to the foot, 2 ft. long; two plates C 7 in. x ½ in. x 7 in. and two seat angles D comprising 6 in. x 3½ in. x 7/16 in. angles 9 in. long; four web plates E 4 in. x ¾ in. x 8¼ in. long. This specimen is to be compared directly with specimen Nos. 1 and 2. It demonstrates the same features as shown by them.

This specimen has a total weight of 442 lbs., there being 7 lbs. 9 oz. of welding wire required to completely weld the specimen. The total welding time was 5 hrs. 5 min. The yield point of the specimen was 50,000 lbs. and the ultimate load 79,900 lbs. The span for loading this specimen was 8 ft. 4 1/16 in. Bending moment at face of column 180,000-inch pounds.

The ultimate failure for this specimen took place by rupture through the web and upper part of weld of one of the beams "A." Upon investigating and removing the beam entirely from the column we found that the overhead welds on the under side of the top flange of the beam were very poorly executed and furthermore that the main weld between the top flange of the beam "A" and the column and also between the plate C and the column was only fused 30 to 40 per cent of the total area. It is interesting to note that even under these conditions of poor welding the specimen carried load to the point of severe deformation of the beams and rupture of the beam web, which was far beyond that which could have been carried by any riveted joint.

**Test No. 6**

Specimen No. 6 was a single cantilever specimen comprising a 12 in. Bethlehem I-beam "A" weighing 28½ lbs. to the foot, 3 ft. long; one 12 in. H column "B" weighing 65½ lbs. to the foot, 2 ft. 6 in. long; a base member F comprising a 12 in. H section weighing 65½ lbs. to the foot, 4 ft. 3 in. long; one seat angle "D" 6 in. x 3½ in. x 7/16 in. angle 7½ in. long; one re-enforcing plate "C" 5 in. x ⅝ in. x 6 in. long; 6 web plates "E" 5 in. x ¾ in. x 10 in. long; one re-enforcing plate "G" 8 in. x ¾ in. x 1 ft. 8 in. long.

This specimen completed weighs 649 lbs., there being required a total of 12 lbs. of welding wire. The time required was 6 hrs. 40 min. to execute the welding. The span from center of load to face of column was 2 ft. 9 11/16 in. The yield point was 35,000 lbs. and the ultimate load 59,200 lbs. Ultimate bending moment at face of column 200,000-inch pounds.

This specimen failed by web crippling of the cantilever beam "A" there being no indication of any distress in any of the welded joints. Incidentally, considerable deformation was produced in the web of the base "F" to the left of the re-enforcing plates "E" located in this base, in line with the right hand flange of column B.

**Test No. 7**

No. 7 was a typical example of a beam of reasonable length compared to the depth when secured to the faces of two rigid columns. The beam "A" is a 9 in. I weighing 21.8 lbs. to the foot, 7 feet 11⅜ in. long. The columns "B" are 10 in. H sections weighing 49½ lbs. to the foot, 2 ft. 3 in. long. The base F is the same section as the column B but is 9 ft. 7¾ in long. The web plates "E" are 4 in. x ⅝ in. x 8¼ in. long. The seat angles D are 4 in. x 3 in. x ⅜ in-5 in. long. The re-enforcing plates C are 4 in. x 7/16 in. x 5 in. long.

The total weight of this specimen was 976 lbs. 8 oz. The total weight of welding wire used was 16 lbs. 3 oz. and the time required 12 hrs. 45 min The span for loading this specimen was 7 ft. 11⅝ in The yield point of this specimen was 50,000 lbs. and the ultimate load 73,500 lbs. Failure by web crippling and flange buckling of beam.

The sum of positive and negative bending moments was 1,760,000-inch pounds. As the welds showed no distress and as the columns did not perceptibly deflect, the negative moment at either end must have been nearly as great as the positive moment at mid-span. For purposes of comparison with tests 8 and 9; assume this test a case of perfect fixed ends, positive and negative moments being each 880,000-inch pounds. This corresponds to maximum fiber stress of 46,500 lbs. per square inch.

**Test No. 8**

Specimen No. 8 was very similar to No. 7, the only difference being the omission of the landing angles D and the re-enforcing plates C.

The total weight of this specimen is 967 lbs., the weight of welding wire required being 15 lbs. The

total time to weld the specimen is 9 hrs. The span for loading this specimen was 8 ft. 3/16 in. The yield point of the specimen being 50,000 lbs. and the ultimate load 67,200 lbs. Failure by web crippling and flange buckling of beam.

It was interesting to note that the ultimate load on this specimen is appreciably less than that on specimen No. 7 which again demonstrates the additional restraint imposed on the beam where seat angles D and re-enforcing plates C are provided.

Sum of positive and negative bending moments was 1,618,000-inch pounds. Assuming same ultimate positive bending moment as in Test No. 7, the negative moment at column face would be 738,000-inch pounds, indicating 84 per cent fixation.

**Test No. 9**

This specimen was made up so as to be directly comparable with specimen 7 and 8, the difference being that the beam "A" is secured to the column B by means of exceptionally rigid riveted joints, using ½ in. top and bottom angles and a total of twenty ¾ in. diameter rivets in 13/16 in. diameter holes.

The span for loading this specimen was 8 ft. 3/16 in. The yield point for this specimen was 42,000 lbs. and the ultimate load 58,700 lbs. Failure by web crippling and flange buckling and bending of connection angles.

It was interesting to observe in comparing these 3 specimens that specimen No. 7 making use of the seat angles and re-enforcing plates shows 25 per cent greater ultimate strength than specimen No. 9. Also, that specimen No. 8 in which only the beam ends are welded to the column without the landing brackets and the re-enforcing plates shows 14 per cent greater ultimate strength than riveted specimen No. 9.

Sum of positive and negative bending moments was 1,410,000-inch pounds. Assuming same ultimate positive bending moment as in Test No. 7, negative moment would be 530,000-inch pounds, indicating 60 per cent fixation. Such a degree of fixation could not have been obtained with an ordinary type angle 5/16" or ⅜" thick.

**Test No. 10**

This was to demonstrate principally a beam subject to shear load. This specimen comprises a 6 in I beam weighing 12½ lbs. to the foot, 2 ft. long secured between two 8 in. H columns weighing 32 lbs. to the foot, 1 ft. 9 in long each and one base member comprising a similar 8 in. H section 3 ft. 4⅜ in. long using four web plates 3 in. x ½ in. x 6⅝ in. located in the base member in line with the inside flanges of the columns. Also two stiffening plates 4 in. x 7/16 in. x 1 ft. long each located as illustrated.

This specimen completed weighs 266 lbs., there being required 7 lbs. 2 oz. welding wire. The total time for making the weld was 3 hrs. 40 min The span for the load was 2 ft. ⅜ in. The yield point of this specimen being 50,000 lbs. and the ultimate load 83,000 lbs. The load was applied at the center of the specimen on a block 5 in. wide located on the top flange of the I beam. Failure in this case took place by web crippling of the I beam.

**Test No. 11**

This specimen was to illustrate two cantilever I beams secured to the web of a larger I beam representing a main girder of a structure. The 9 in. I beams weighing 21 8/10 lbs. to the foot are 3 ft. long. The 15 in. I section weighs 42 9/10 lbs. per foot and is one foot long. The two seat angles are each 4 in. x 3 in. x ⅜ in. 5 in. long.

Owing to the very cramped and inaccessible space between the top face of the 9 in. I beam flanges under the upper flange of the 15 in. I section, it was next to impossible for an operator to make a good weld at this point where the tension stresses are concentrated. Therefore to assist in welding, wedge blocks were inserted so as to permit the operator to build up arc deposited metal over the end and edges of these wedge blocks thereby producing a tie between the flanges of the 15 in. I and the flanges of the 9 in. cantilever I beams. This specimen complete weighs 187 lbs., there being required 4 lbs. 2 oz. of welding wire and the total welding time required 2 hrs. 10 min.

The span for loading this specimen was 5 ft. 7⅝ in. The yield point of this specimen was 55,000 lbs. and the ultimate load 64,000 lbs.

**Test No. 12**

Specimen No. 12 was similar to specimen No. 11 with the exception that the 9 in. I beams are coped so as to throw the top face of the top flange in a plane with the top face of the top flange of the 15 in. I beam. A re-enforcing plate 5 in. x ½ in. x 1 ft. 10 in. long is provided across the specimen as illustrated. This re-enforcing plate was wider than the flanges of the 9 in. I beams which necessitated welding overhead in order to tie the edges of the top flanges to the under surface of the re-enforcing plate. This design should be revised so as to make the re-enforcing plate narrower than the I beam flanges thereby providing for welding in the downward position.

The total weight of this specimen was 194 lbs., the welding wire required was 3 lbs. 12 oz. and the total welding time 2 hrs. 15 min. The span for loading was 5 ft.-4 15/16". The yield point of this specimen was 65,000 lbs and the ultimate load 94,000 lbs. The ultimate failure taking place by progressive tearing of the overhead welded joint between the re-enforcing plate and the top flange of one of the 9 in. I beams. This specimen shows a very material increase in strength over that of specimen No. 11 namely, approximately 48 per cent.

**Test No. 13**

Specimen No. 13 represented a test of two spliced 10-inch Bethlehem I beams, each weighing 23.5 pounds to the foot, 3 ft. long, welded together at their abutting ends and reinforced by top and bottom cover plates, each of which is narrower than the flange of the beam so as to permit downward welding along the edge of the cover plate to the outer faces of the beam flanges. This particular specimen was considered a shop fabricating job, and therefore the beam was turned over so as to make all welding in the downward direction, whereas all of the preceding specimens were welded in the position shown to exactly duplicate regular building construction work.

Failure took place in this specimen by web crippling of the two joined 10-inch I-beams. The elastic limit of the specimen was approximately 65,000 pounds, and the ultimate load was 72,900 pounds. The loading span was 6 ft. 6-1/16 in., the load being concentrated at the center on a loading block 5 inches wide. This gives a maximum bending moment of approximately 118,000 foot pounds, and represents a fibre stress of approximately 58,200 pounds per square inch in the beams at the ultimate load.

The weight of this specimen complete is 180 pounds 9 ounces, it being required to use 1 lb. and 11 oz. of welding wire and the total actual welding time of 1 hour and 15 minutes.

**Test No. 14**

This specimen was to represent a small bracket secured to a column, the bracket comprising a 6″ x 4″ x 1/2″ angle, 1 ft. 6½ in. long, welded across the end and the top and bottom edges. The 8-in. H colmun weighs 32 pounds to the foot and is 2 ft. 2 in. high. Failure took place in this specimen by buckling of the column flange edge, midway between the bracket and the lower supporting channel welded to the column and to the base. The web of the column was also distorted at the same time. The yield point for this specimen was 25,000 pounds, and the ultimate load was 34,600 pounds. The span from the center of the applied load to the edge of the column was 7½ in. The maximum bending moment therefore is 21,700 ft. pounds, and the maximum fibre stress in the angle is 59,500 pounds per square inch.

The weight of this specimen is 148 lbs. 8 oz., and the amount of welding wire required is 3 lbs. 3 oz., and the total welding time is 1 hr. 25 min.

**Test No. 16**

This specimen comprised a pair of 15/16-in. diameter hot rolled steel rods welded to the two faces of the 12-in. I-beam weighing 31.8 pounds to the foot, 6-in. long. It is to represent the construction where similar rods are to be attached to the bottom faces of the I-beams and girders for hangers to support balconies and mezzanines. Each rod was welded to the under face of the I-beam in an overhead position to exactly duplicate field construction work. The specimen failed by breaking the rod approximately 12-in. from one face of the I-beam section. The yield point was 23,200 pounds, and the ultimate load 35,000 lbs. The amount of welding wire required to weld both rods to the I-beam is 8 oz., and the total welding time 45 minutes.

**Test No. 17**

This specimen comprised 2 angles 2½″ x 2″ x 3/16″ 4 ft. long, welded to two plates 5 in. x ¾ in. by 1 ft. long, the 2½ in. leg of each angle being welded to the plates across the ends of the angle and along the heel and toe of the leg of the angle in contact with the plate. The specimen is for a tension test, the yield point being at 70,000 lbs., and the ultimate load being 94,000 pounds, the maximum elongation being 3 in. in the 40-in. length between shank plates. Failure took place by progressive failure through the 2½-in. legs of the angles, carrying on out through the 2-in. leg.

The complete specimen weighed 48 pounds 7 ounces, the amount of welding required was 8 oz., and the actual welding time 20 minutes. All of the welding in this specimen was done in the downward direction, which shows the difference between overhead welding and downward welding by comparing with the amount of metal used and welding time for specimen No. 16. In the case of these two specimens, the amount of welding wire used was exactly the same and yet the welding time was 20 minutes in the case of No. 17 against 45 minutes in the case of No. 16. Mean tensile stress, ultimate, 58,000 lbs. per square inch.

**Test No. 18**

This specimen was similar to specimen No. 17, the difference being that the angles were riveted to the shank plates with 5/8-in. diameter rivets power driven in 11/16-in. diameter holes.

The elastic limit of this specimen was 60,000 pounds and the ultimate was 72,000 pounds, and the elongation was only 1.12 in., failure taking place through the first rivet hole. The stress strain diagram curves of these two specimens make a very interesting comparison. Ultimate mean tensile stress on gross section 44,500 lbs. per square inch; on net section 53,000 lbs. per square inch.

**Test No. 19**

This specimen comprised a 15-ft. by 14¾-in. deep girder employing one web plate, A, 14″ x 5/16″ x 15 ft. long, 4 flange angles, B, 4″ x 3″ x 5/16″, 15 ft. long; 16 web stiffener angles 3″ x 2″ x ¼″, 1 ft. 1¾″ long; 12 filler plates 2½ in. x 5/16″ x 8⅝″ long, and 2 filler plates 5″ x 5/16″ x 8⅝″ long. The parts of this girder were assembled by welding. The top flange angles were welded to the web plate by intermittent welds 1 in. long on 3-in. centers along the toe of both the top angles. The backs of the angles were welded together and to the edge of the flange plate intermittently using 2-in. long welds on 3-in. centers. At each end the angles were welded solid to the web plate at both the heel and toe for a distance of 3 in. The bottom flange angles were welded to the web plate solid for a distance of 6″ at each end of the toe, the remainder of the weld along the toe of the angle being 2 in. on 5-in. centers. The heels of these angles were welded solid and also to the edge of the web plate for a distance of 6 in. The remaining portion of this same joint was intermittently welded 2 in. on 5-in. centers. The filler plates were welded to the web plate by means of 2-in. long welds at the neutral axis and 1/2-in. welds at the ends of the filler plates along the web plate. The stiffener angles were completely welded around the entire periphery making contact with the flange angles, and also 2-in. welds at the heel and toe of these angles exactly in line with the 2-in. welds made at the edge of the filler plates to the web plate. The completed specimen weighed 785 pounds. The amount of welding wire required to complete the specimen was 27 pounds 8 ounces. The total time to complete the specimen was 14 hrs. and 10 min. The specimen was tested by center loading on a block 5 in. wide, the span being 14 ft. The speciman failed by crippling of the top flange of the girder, the elastic limit being reached at 65,000 pounds, the ultimate load being 77,200 pounds, and the maximum bending moment being 270,000 ft. pounds. This

gives a maximum fibre stress of 53,800 pounds per square inch based on the section modulus of 60.2.

**Test No. 20**

Specimen No. 20 was a 15-ft. girder 14-15/16 in. deep, made up of duplicate parts used for specimen No. 19, except that all parts are riveted together using ¾ in. diameter rivets power driven in 13/16 in. diameter holes. The completed weight of this specimen was 798 pounds. This specimen was tested by center loading on a block 5 in. wide, the span being 14 ft. and 1/8 in. Failure took place by buckling of the top flange, the yield point being 55,000 lbs., and the ultimate load being 68,900 lbs. A duplicate girder was also tested, the span being 14 ft. 3/16". The elastic limit was reached at 60,000 lbs., the ultimate load being 74,000 pounds, the depth of this girder being 14-15/16". Maximum fibre stress, ultimate, for first specimen, 47,400; for second specimen, 51,000; section modulus for both specimens 61.1.

By comparing these figures with those for specimen No. 19 it is interesting to observe that although all parts joined were exactly the same, the welded specimen had a higher yield point than either of the riveted specimens, and also an ultimate load carrying capacity appreciably above that of the riveted specimens. Allowance should also be made for the fact that the depth of the welded specimen, namely No. 19, was less than either of the specimens No. 20, causing 1½ per cent less section modulus.

**Test No. 21**

Specimen No. 21 was a specimen designed strictly to take all advantage of the possibilities of joining structural steel members by the use of arc welding. In this respect it is entirely different from No. 19 which is simply a riveted design welded.

The specimen comprises a web plate, A, 14" x 5/16" x 15 ft. long; 2 flange plates, B, 10" x 3/8" x 15 ft. long; and 16 web stiffener plates 3" x 1/4" x 1 ft. 1¾" long. The top flange was welded to the web plate continuously along each side of the web plate. The bottom flange was welded to the web plate solid for a distance of 6 in. from each end and then intermittent welds 2 in. long on 4-in. centers the rest of the distance on each side of the web plate. The web stiffeners were welded solid to the flanges around the entire periphery at each end of each web stiffener. Each web stiffener was also welded 2 in. on each side at the neutral axis and at intermediate points 1 in. long at each side of each stiffener halfway between each stiffener and the flanges of the girder. This specimen was tested by center loading on a block 5 in. wide, the span being 14 ft. Failure took place by buckling of the top flange. The elastic limit of the specimen was 65,000 lbs., and the ultimate load 78,000 pounds. This specimen had a total finished weight of 656 lbs., which is very materially less than that of the riveted girder, namely approximately 18 per cent, and approximately 16½ per cent less than the weight of the riveted design welded, namely specimen No. 19. A total of 30 lbs. 2 oz. of welding wire was required, and the total welding time was 12 hrs. and 33 min. This shows the advantage of designing structures for welding, by placing the metal in the locations where the greatest strength can be developed with the amount of material used. It also demonstrates the fact that the parts to be joined need not be lapped as is required where rivets are to be used for securing the members. Maximum fibre stress 52,700 lbs. per sq. in. section modulus 62.2.

**Test No. 21-A**

Specimen No. 21-A was similar to No. 21, except that the web stiffening plates are 4½" x 1/4" x 1 ft. 2 in. long, there being a total of 20 used and a top reinforcing plate 9 in. x 5/16" x 6 ft. long was welded to the top flange. This plate was welded solid across each end and solid along each edge from the center of the girder to a point 1 ft. 2 in. from the center of the girder. The remaining length of the edge of the plate was welded intermittently, 2-in. welds on 4-in. centers. This girder had a completed weight of 795 pounds, and required 30 lbs. 12 oz. of welding wire to complete the welding work. The total welding time was 16 hrs. 50 min. This specimen failed ultimately by buckling of the top flange, the top cover plate blistering away from the flange at the center where it was tied into the web plate. This blistering was approximately 1/2 in. in depth and did not result in the cracking of any of the welds. The elastic limit of this specimen was reached at 60,000 pounds and the ultimate load was 110,350 pounds. A very interesting feature developed in connection with this test, namely when the ultimate load was removed from the girder it sprung upward a distance of 3/4 in. before coming to rest. Some very interesting comparisons can be made between this girder and the two preceding girders 19 and 20, which will show the very decided increase in strength which can be obtained by properly designing to take advantage of the possibilities of arc welded construction. The maximum bending moment in the case of this specimen is approximately 386,000 ft. lbs. The maximum fiber stress in tension would appear to be 69,300 pounds per square inch, based on a section modulus of 66.8; but the buckling of the top flange before ultimate load was reached would naturally lower the neutral axis below the calculated position, so that the figure given above for maximum tensile stress is undoubtedly much too high. At the elastic limit, the figure for tensile stress is 37,700 lbs. per square in.

The design of the test specimens described above, and the design for the welded steel building for the Westinghouse Electric & Manufacturing Company at Sharon, Pa., were produced by Mr. Gilbert D. Fish, consulting structural steel engineer, co-operating with the arc welding engineers of the Westinghouse Company. This whole series of test specimens and the design of the Sharon building has been made possible through the foresight of Mr. W. S. Rugg, vice president in charge of engineering, who for some time past has appreciated the possibilities which lay in the use of arc welded structures.

All material for these test specimens was furnished gratis by the American Bridge Company, and was specially prepared under the direction of Mr. Marshall Williams, assistant to president of that company. Complete data upon the physical properties of all of this steel, including tensile tests and chemical analyses were also supplied, and great care was taken in selecting the steel material so that insofar as possible, it would be from the same heat so as to secure uniformity in comparing the various specimens.

All of the testing work was carried on at the Carnegie Institute of Technology by Mr. J. M. Daniels, instructor in charge of the Materials Testing Laboratory, and his assistant, Mr. Arthur Haeppel. The actual welding of the specimens and all records of tests were carried out under the direction of Mr. A. M. Candy, welding engineer, and Mr. C. T. Eakin, of the Material and Process Engineering Department of the Westinghouse Company.

The Westinghouse Electric & Manufacturing Company hereby desires to record acknowledgment of the service rendered in this work by all of the above mentioned parties and assistants working under them.

# *Discussion of Electrification of Plant Railroads*

By WALTER GREENWOOD*

IN the discussion of electrification of plant railroads nothing has been said bearing on safety features and only one view in the publication of papers here presented, published in advance of this meeting, shows the application of a safety feature that should get more attention now while this new addition to transportation equipment is in its infancy. This feature is a platform on each end as shown in figure 5, page 269 of June issue Iron and Steel Engineer, which shows an 1000 H. P. Diesel electric locomotive for main line service. Heretofore it never has received any consideration for application to main line service, but for switching service it has to some slight extent been adopted. Its importance is much greater in switching service where getting on and off occurs most frequently, and we might say, without exaggerating, hundreds of times as often as in main line service.

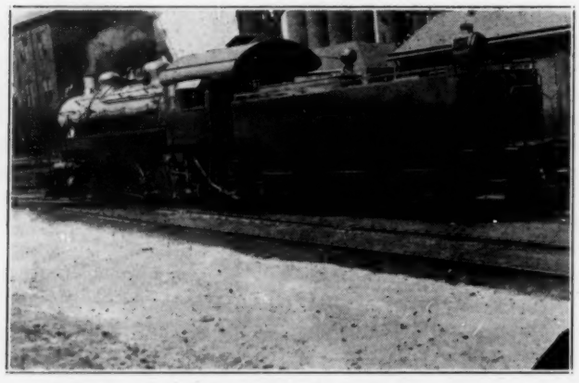

FIG. 1.

Locomotives generally used in switching are supplied with a foot board on front end and on rear end of tender, for men engaged in shifting cars to ride on. Riding on these footboards is a necessary though dangerous practice. The cost for fatalities and serious injuries resulting from so doing amounts to a tremendous sum for compensation settlements in addition to that occasioned by the loss of productive capacity, which must be borne by dependents along with the community at large.

The building of electric locomotives is practically in its infancy and from present indications its growth is bound to be very rapid. The expense of substituting passenger type platforms on the ends of new locomotives, and the added cost for maintainance for a period of two years, would be no more than the cost of installing and maintaining foot boards for a like period of time. Following this period the cost for maintainance of platform would be insignificant, while in the case of footboards the cost would be a very large item of expense. The cost of installing these platforms on old locomotives is three or four times as much as it would have been had they been installed when the locomotives were built. The cost in one case where they were installed on ten old locomotives and seven new ones was $150.00 for new and about $600.00 for those already in service. Presumably the ratio of 1 to 3½ or 4 would hold through all periods of fluctuating prices. However, experience has proved that this higher cost would be profitable in all cases. One general safety committee, composed of members representing the various plants of a large division of the U. S. Steel Corporation, has approved them and these divisions have made several installations that will be followed by others.

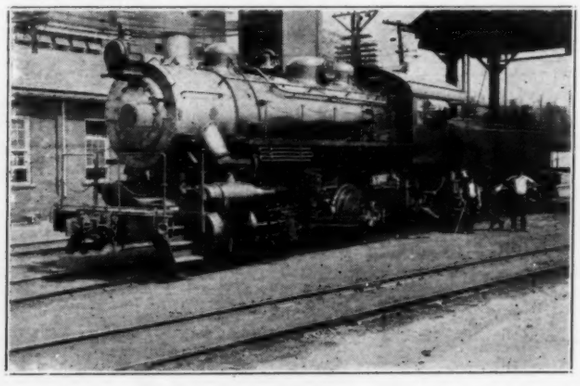

FIG. 2.

These platforms and steps should be placed on each end of every locomotive that in the future may be built. We are aware builders can only comply with requirements of specifications furnished by customers, yet, as in the case of introducing all other improvements, the manufacturers can use an influence that will tend toward general adoption and, perhaps, standardization by the U. S. Bureau of Standards.

It would be practically impossible to compel or induce the owners to equip their steam locomotives now in service with these platforms, although we may claim it would be profitable to do so. It should be possible to induce purchasers of new locomotives to include them in the specifications if they will con-

*Safety Engr., Carnegie Steel Co., Youngstown, Ohio.

sider that the slight addition to cost will be entirely wiped out with two years' service, and following this there will be a saving in maintainance expense. Probably it will not be long before the Interstate Commerce Commission will include in their rules for construction of railroad equipment one that will compel the installation of platforms on locomotives. If the claims we are making can be proved, and we stand ready to prove them, why would it not be best to anticipate their demands by starting to do it along with the introduction of electric locomotives? I can think of no addition to railroad equipment, since the introduction of air brakes and automatic couplings that would do as much toward lowering accident hazard and promoting efficiency as would these platforms. Every objection ever offered against them has been discussed and proven by practice to be without foundation. Their chief merit lies in avoidance of accidents. They permit of greatest expedition in doing work. It is a matter of great importance for someone to ride on front end of locomotives considering the direction they are moving, and these platforms afford a convenient and safe place to ride. They afford a place for carrying injured persons who cannot be conveniently carried in the cab. The other purposes they can serve are numerous.

Now is the time to start in making installations of this addition for which there some time will be a general demand while the cost will be nothing on new locomotives, but will be considerable if they are added after the locomotives have been built and put in service.

# *Items of Interest*

An order for the largest horizontal waterwheel generators ever built, consisting of two 45,000 kv-a units, has been received by the Westinghouse Electric & Manufacturing Company from the Southern California Edison Company. These units will form the No. 1 and No. 2 units of that company's Big Creek 2-A station. These two units set the record for size, the next largest on order being 33,000 kv-a capacity, and the next largest in service a 28,000 kv-a capacity, and the next largest in service a 28,000 kv-a Westinghouse machine.

The two 45,000 kv-a horizontal waterwheel generators will be totally enclosed and complete with suitable direct connected exciters and usual accessories. Their total weight will be about 600,000 lbs. each, the overall width and height being respectively approximately 25 feet and 23 feet. The length of the generator itself will be about 14 feet.

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The Cutler Hammer Manufacturing Company, in publication C-34 describes Inductive Time Limit Control. The Publication is profusely illustrated with installations in the Iron and Steel Industry. The curves obtained with the oscillograph, cover acceleration and plugging and illustrate the performance of the ITL controller under heavy overloads, also curves showing conditions with a motor operating under no load, fifty per cent load and normal full load conditions. Upon application the Cutler Hammer Manufacturing Company at Milwaukee, Wisconsin will be glad to forward you this publication.

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Bulletin number 810 issued by the Roller Smith Company, 233 Broadway, New York, covers Radio Frequency Ammeters, Milli-Ammeters, Current Squared Meters. The Selection of the principle and design of mechanism involved in the different types of instruments listed in this Bulletin is the result of years of development work and the production of many thermal instruments. Roller Smith Company will be glad to furnish this bulletin on request.

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The Trumbull Electric Manufacturing Company, Manufacturer of Electrical Supplies, Plainville, Conn., announces a new Four Circuit Residence Panel. Write L. L. Brastow, Sales Manager and he will be glad to forward you a circular describing all of the features of the new Residence Panel.

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The United States Graphite Company, Saginaw, Michigan, U. S. A., has just mailed out to the trade their catalogue number B-4, which describes the products of this company. This catalogue contains forty pages of very interesting information. Requests made to the company for this catalogue will be honored.

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The Shepard Electric Crane & Hoist Company, Main Office and Works, Montour Falls, New York, has just issued a sixteen-page bulletin which covers Lubrication Instructions for the Shepard Electric Crane & Hoist. This catalogue is a work of art and represents a very heavy investment. The technical discussion contained in this catalogue discusses the hoisting unit, bridge drive motors and gearing unit, bridge truck gearing, truck wheel bearing, hoisting cable, hoisting tackle, plain trolleys and electrical apparatus. When writing for this bulletin ask for publication number 98.

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The General Electrical Company, Schenectady, New York, has just issued a very attractive seventy two page bulletin covering distribution and small power transformers. This bulletin is known as GEA 424 and will be mailed upon request.

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The Kuhlman Electric Company of Bay City, Michigan, manufacturers of Power, Distribution and Street Lighting Transformers, announces the establishment of a factory office at 3-260 General Motors Building, Detroit, Michigan. Mr. Richard P. Johnson will have charge of this office.

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"The Keystone Safety Lubricator; Questions Answered and Typical Installations Illustrated." As its title implies, it is a thorough discussion of the lubricator, its purpose, method of operation, relation to safety, adaptability, etc. Various types of installation are discussed and illustrated together with the accessories that have been designed to reduce the

time of lubrication attention as close as possible to zero.

The close relation of lubrication to safety and to overhead costs brought about the development of the Keystone Safety Lubrication, and the booklet is built up around this much neglected branch of engineering practice. It has just come from the press and is available to any executive or operating man who is interested in safety and efficiency. Copies may be obtained from the Keystone Lubricating Company, Twenty-first and Clearfield Streets, Philadelphia, Pa.

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A combination air compressor and arc welder driven by a gas engine and mounted on a single base has been placed on the market by Schramm, Inc., of West Chester, Pennsylvania. The outfit consists of a Buda gasoline engine, a Schramm compressor and a General Electric welding outfit. The complete equipment may be mounted on a standard two-ton truck or can be made portable by adding steel or rubber-tired wheels.

The Buda engine is a 24-horsepower, 800 r.p.m. unit, which may be started and operated independently of either the compressor or welding generator. The Schramm compressor is a two-cylinder, water-cooled machine with a capacity of 120 cubic feet per minute and equipped with an automatic unloading device. The air receiver is 16 inches in diameter by 42 inches high. The General Electric welding equipment consists of a belt-driven WD-12 arc welder with an idler pulley for belt tightening. By the use of a Borg & Beck 12-inch clutch coupling, either of the machines may be connected to the engine.

This combination outfit is expected to be of great value in field work. The air compressor can be used to operate drills, grinders and chipping hammers for cutting, peening, caulking and cleaning off scale. The compressor can also be used in preparing work for welding. With the G-E WD-12 welder light and heavy gauge steel can be welded as well as cast iron. After the welding is completed, the compressor clutch is thrown and the weld can be ground or chipped as desired. Thus a complete job can be done with the single machine.

The structural steel base is 8 feet 4 inches long, 5 feet 11 inches wide. The outfit is 3 feet 10 inches high. The total net weight of the outfit is 4,000 pounds.

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Ushering in a new era of structural steel erection, which promises to save millions of tons of steel yearly and heralds the death of the nerve-wracking rivetting hammer, Vice President W. S. Rugg, of the Westinghouse Electric & Manufacturing Company has just announced the letting of contracts for the erection of two arc-welded structural steel buildings on his company's properties.

The contracts were announced before representatives of various structural steel concerns, technical societies and technical publications, gathered in Pittsburgh Wednesday and Thursday, July 28 and 29, to witness tests in the laboratories of the Carnegie Institute of Technology of arc-welded steel joints and columns prepared by the Westinghouse engineering department.

The two proposed structures announced by Mr. Rugg include a one-story building to be used as an engineering laboratory in the East Pittsburgh Works and a five-story mill type building to be used in the manufacture of transformers in the Westinghouse Sharon Works.

Both structures will make steel history. The five-story building at Sharon, when completed will be the largest arc-welded or rivetless building in the world and is the first practical application of arc-welding to the building of multiple-storied structures. It will be the first building in the world with all joints and members designed for arc-welding. It is a radical departure from previous practice in that practically none of the members could be joined except by arc-welding. Its cost will be about $275,000. The one-story East Pittsburgh structure is epochal in that it is being erected partly of scrap roof trusses, a feat economically unfeasible heretofore.

Arc-welding as applied to the erection of structural steel has been in process of development by Westinghouse engineers co-operating with the American Bridge Company for some time during which tests conducted in the Carnegie Institute laboratories of material prepared by Westinghouse arc-welding engineers has developed the fact that arc-welded joints were stronger than riveted joints, and were in fact, stronger and more resistive to pressure and stresses than the adjacent beams. It was also found that the saving in steel effected in arc-welded structures was considerable, not only because of the elimination of the thousands of plates and angles now necessary in rivetted buildings, but also because lighter beams could be used thus making the entire structure weigh less. In rivetting construction, the size of the beams is frequently determined by the strength required of the rivetted joint rather than of the members joined. In the Sharon building where approximately 700 tons of steel will be used, there is 100 tons less steel than would be necessary if the structure were to be rivetted. This alone means a saving of about 12 per cent in steel cost. A considerable benefit to be derived from arc-welded structures also lies in the elimination of the noisy rivetting hammer, whose nerve-wracking noises now herald the erection of all steel structures.

G. D. Fish, consulting engineer of New York, also assisted in the preliminary tests. Bernard H. Prack is the architect on the Sharon building.

In the steel fabricating mill, the arc-welded members will entail a decided change in the process of assembly. The present system includes the design of thousands of angles and bracing plates, all of which, together with the beams, are laid out and punched, before being delivered to the rivetting gangs for assembly. In the new process, the work will be laid out on the floor where the arc-welder, with his grotesque hood and electric arc will supplant a gang of rivetters.

According to Marshall Williams, assistant to the President of the American Bridge Company, the new process means a return to days of long past in structural steel history, when nearly all of the men in the shop had to have practical knowledge and skill in the fabrication of steel members.

"It will mean a development and skilled knowledge of the assembly of steel members from beginning to end. Arc-welded jobs, must be laid out on the floor, which will eliminate a number of processes

now used, by which the steel members, are delivered to the shop workers, already punched and fitted. The assembly process in arc welding will undoubtedly require a higher average type of workman and more technical supervision.

"Structural steel fabrication costs have been reduced to a minimum so that new arc-welded processes will hardly effect savings in the assembly. However, great savings will come with the elimination of the thousands of angles and braces, which now go into all steel structures and which are eliminated by arc-welding. These savings will be exceedingly large. For instance, in the five-story Sharon structure, 100 tons less steel, will go into it as an arc-welded structure than would have been necessary were it to be rivetted.

"In the actual erection of steel structures, there will also be a change. The type of steel raiser will probably not differ in the future, but of course, the rivetting gangs will be supplanted by crews of arc-welders."

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The Graybar Electric Company, Inc., has announced its plans for consolidating its three offices in New York City in the largest office building above ground in the world. This building, which is being erected by the Todd, Robertson, Todd Engineering Corporation right next to the Grand Central Terminal, between Forty-third and Forty-fourth Streets, on Lexington Avenue, west of Depew Place, will be known as the Graybar Building. It was designed by the firm of Messrs. Sloan & Robertson and will have a forty-foot concourse which will lead right into the Grand Central Station and will serve as the Eastern entrance to that important terminal. The building will be ready for occupancy by May first of next year.

This will be a particularly attractive site for the executive offices of the Graybar Electric Company because this organization has sixty other offices in various cities throughout the country and these can be reached by mails or in person in a minimum of time from this central location.

The fifteenth floor alone of the Graybar Building contains approximately 40,000 square feet of space. The Company has rented this floor from Eastern Offices, Inc., owners of the building. Large offices on the Lexington Avenue front will provide special facilities for Mr. A. L. Salt, President, Mr. F. A. Ketcham, Executive Vice President, Mr. G. E. Cullinan, Vice President, in charge of sales, and Mr. L. M. Dunn, Vice President, in charge of staff. Behind their offices will be those of the other administrative and executive officers, and those directly in charge of sales will be at the back of the building in Depew Place. Practically this entire floor will be divided into private offices which will include those of the advertising and legal departments and the secretaries.

The Graybar Company was incorporated on the first of this year, and took over the functions of the Supply Department of the Western Electric Company which was started fifty-six years ago. It is interesting to note that the Graybar Company derives its name from the old firm of Gray and Barton which founded the Western Electric Company. It wholesales everything electrical of a commercial nature made and supplied not only by the Western Electric Company, but by other electrical manufacturers. Its customers, which include public service corporations, railroads and other large organizations, as well as smaller concerns, number approximately 35,000, and these in turn sell at retail to many millions of individuals. The Company is capitalized at $15,000,000, and its business last year amounted to $66,000,000.

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The Harnischfeger Corporation wishes to announce the appointment of H. S. Beale as Sales Engineer in New York territory with offices at 50 Church Street, New York.

Mr. H. A. Wolcott, formerly in charge of the Miami office, has been made District Manager of the New York territory, with headquarters at 50 Church Street, New York.

The Harnischfeger Corporation also wishes to announce the appointment of S. B. Dubier as Sales Engineer in charge of the Miami District with offices at 343 S. W. River Drive, Room 306, Miami, Florida.

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When the New Manchester Plant of the Pittsburgh Transformer Company was completed, it was decided to install a new sub-station to take care of the electrical service of the five plants of the Company. The plant expasion has been so great in the last five years that it was necessary to take steps to supply adequate service for power, lighting, testing, etc.

Bulletin No. 2056 is a description of this new sub-station, and contains information concerning the installation, as well as interesting photographs and drawings of the layout.

This bulletin, we believe, will be of interest to many of our readers, both those who are contemplating such a commercial installation and those who are designing such stations, and The Pittsburgh Transformer Company will be glad to supply copies to any of our readers who might wish same.

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## NINE HUNDRED AND SEVENTY-SEVEN DAYS—NO LOST TIME ACCIDENTS*

### Electrical Department Establishes an Excellent Record

Human life is most precious and its conservation is the first thing to be considered by any Safety Organization. The loss of even a single life or the cause of a serious accident and the efforts of the entire organization for the prevention of accidents has in some manner failed.

The Electrical Department, Joliet Plant, Illinois Steel Co., have earnestly endeavored to extend an effort to be of service in the conservation of life and limb by the elimination of all accidents and their causes, not alone in their own department, but over the entire plant as well.

That they have been successful in their efforts is well defined by the accomplishments recorded in their department in Accident Prevention.

The records of this department indicate the wonderful spirit of co-operation by each individual to make their goal, to make their individual efforts count by worth while efforts. These excellent records are an indication of what Safety Efforts right and justly placed, can do; and these committeemen

*Joliet Plant, Illinois Steel Co., Joilet, Ill.

are to be highly congratulated on their successful showing in this cause.

Eleven years of Safety Efforts have produced one of the best achievements by this department, that has ever been recorded in Accident Prevention by a like department.

With a total of but eleven lost time accidents for the last eleven years period, or an average of but one lost time accident per year, they have been successful in recording but one over seven day or serious accident over this entire period, making a real accomplishment and a service of good to their fellow workers.

The first notable record was made from March 30, 1915, to August 3, 1916, inclusive, a period of 493 consecutive days without a single lost time accident. This record was followed by many more notable periods making each a record and an accomplishment.

The periods from August 5, 1915, to January 19, 1917, 534 consecutive days, from January 21, 1917, to May 1, 1917, 101 consecutive days, from May 3, 1917, to February 16, 1919, 655 consecutive days, from February 22, 1919, to May 9, 1921, 809 consecutive days, from May 11, 1921, to November 21, 1921, 195 consecutive days and from February 23 1922, to November 5, 1923, 621 consecutive days without a lost time accident, are records and accomplishments that the men of this department can be proud of.

The last lost time accident recorded was caused on November 6, 1923, and from this date to July 10, 1926, inclusive, a period of 977 consecutive days are recorded without a single lost time accident, making their present record their best accomplishment.

Mr. Frank Kittredge, Chief Electrician, Mr. Thomas Barrett, his assistant, their associate foremen, all of the present and past Committeemen and each individual in the department are to be congratulated on their successful efforts in Safety, making possible the prevention of accidents and these distinctive records.

## PREVENTABLE ACCIDENTS*

### The Best Known Safety Device Is a Careful Man

Most accidents are unnecessary and entirely preventable. Furthermore, in nearly all instances, the occurrence lies entirely with the individual. Safety devices are an important part of any accident prevention campaign. But the best known safety device is a careful workman.

Each month on this page we present a number of causes of accidents which have been gathered from various sources and which clearly indicate that accident prevention means—think.

An electrician was removing insulation from wire by laying wire on his knee and scraping it with a knife. The knife slipped off of the wire and struck him in the knee inflicting a painful wound—think.

A workman had a hold on hot rod with tongs on delivery table to throw rod onto hot bed. When rod was thrown from table he did not release his hold on hot bar with tongs as he should have done and he was pulled from table onto hot bed striking hot bars on bed—think.

Ladle liner was loaming up hot ladle with the use of a loam brush when a drop of hot loam from brush splashed into his eye. He was not wearing goggles at the time accident occurred and he did not report to the Dispensary immediately after its occurrence as required by the Safety Rules and the Regulations of his deaprtment, but instead, he waited for three days and until a serious infection had developed and it was necessary to remove him to the hospital where proper treatment could be administered to save the sight of the eye—think.

A machinist apprentice was using grinding wheel to grind a small lathe tool. In pressing tool to wheel he pressed too hard, causing the tool to turn and his finger to strike wheel—think.

A laborer, working in cellar under shears, attempted to throw butt from cellar without the use of hand leathers or gloves. As butt left his hand a protruding sliver caught his finger and he received a bad laceration—think.

A workman was dressing emery wheel in shop with regular emery wheel dressing tool. Careful instructions are given and only experienced men allowed to do this work that unusual care may be used by the workman doing this work. This injured man became careless and did not properly adjust eye shield for his use on the job and he was struck in eye by particles of emery from wheel—think.

Repairman had removed caps from cells in battery to clean them out. While pouring solution from cells of battery into a barrel, a piece of metal from battery fell into the solution in the barrel causing it to splash and strike his face—think.

Scale repairmen were cleaning scrap away from east mixer scales. Before starting this work men working on floor above had been notified that this work was to be done and scale men were informed that all would be safe.

Gas had been turned off of mixer and it was being fired with wood by men on floor above and directly above scale men working on scales. A timber was started into mixer but missed mouth and fell through floor striking repair man and injuring him—think.

Set of moulds had been switched to stripper house for stripping and engineer left cab on the right side of engine to do some oiling when he slipped on loose scrap on ground and fell against mould striking his arm on sharp edge of scrap inflicting a painful injury to his arm.

There is always the same danger in allowing scrap to lay around on ground where there is danger of men passing and to be successful, each department must first eliminate this hazard—think.

A helper was assisting in removing boring bar that had been placed in steam cylinder. A crane hitch had been made on middle of bar to remove it and as crane lifted bar it began to move out from cylinder causing blocking, upon which it rested, to tip.

Injured man had been warned by other men in the gang to stay in the clear and that it was not necessary to perform the work he was about to do but he did not heed their warnings and picked up small steel block to strike wooden blocking.

When he struck wooden blocking it fell catching his hand and steel block he was holding. The steel

*Taken from the Mixer Plant Publication, Joilet Plant, Illinois Steel Co., Joliet, Ill.

block was caught by wooden blocks and his fingers were pinched between these and steel blocks and he received a very serious injury to his fingers—think.

A workman was helping to cut wood at electrical operated saw in yard when he stepped on a protruding nail in board carelessly left on ground.

The days of accidents from this hazard will not be over until every man on the plant can learn to think.

Sailors were using a small hand winch on top of machinery while doing repair work.

Injured man, an experienced sailor, attempted to unwind some of the rope from drum on winch by pulling on rope while standing close to winch instead of using the regular and right practice of doing this by crank.

As the rope on drum was pulled free drum revolved with this and crank fastened to drum struck him—think.

Do your duty to yourself, your home, and society by being a careful man.

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The Carnegie Steel Company has ordered an eighty-ton, swivel truck, third rail type locomotive for use on the "hot metal elevated" at its Edgar Thompson Works, Braddock, Pa. It is the first electric locomotive of its size to be ordered by a steel manufacturer for yard service. The service conditions are ideal for electrification. Operations are sufficient to keep the locomotive busy and at the same time are somewhat isolated from other yard work. Power for the third rail system is available from the mill circuit.

The run over which this locomotive will operate is approximately half a mile long, extending from the "bull pen" to the mixer building. This track is known as the "hot metal elevated" as it passes over several other yard tracks and the tracks of the Baltimore & Ohio Railroad. More than half of the run has a grade of 2.75 per cent, a portion of which lies in a curve of 300 feet radius. This combination of a heavy grade and a sharp curve makes the operating conditions unusually severe.

The maximum train contemplated consists of five loaded ladles weighing 72 tons each and a 15-ton caboose. The locomotive must be capable of starting this train at the worst position on the run which, of course, where the train is located on the heavy grade and curve. With a conservative factor of adhesion of 25 per cent, an adhesive weight on the drivers of 80 tons is required.

An average train will consist of four ladles, each containing twenty-five tons of metal, and will complete the cycle of one run in twenty minutes. This service is of 24-hour duration seven days a week. The locomotive, therefore, must essentially be of very rugged construction to withstand such demands of service, and also have an ample margin electrically. All the spare capacity which is contemplated consists of one motor truck complete in all details including third rail shoes and with motors installed.

The cycle of operation calls for several switching movements, but is essentially as follows: Couple to loaded ladles in the "bull pen" and move out onto the "hot metal elevated" track, reverse, couple on caboose and proceed up the "elevated" with the caboose and ladles ahead. The caboose is switched out of the way at the upper end of the run and the ladles placed in the mixer building. The locomotive then returns with empty ladles and the caboose, placing the empty ladles in the cleaning shed. It is planned to transport 6,000 tons of hot metal per day in this way.

Current will be collected from a double third rail at 230 volts. For the present at least, the power will be taken from the mill power system, and as it is undesirable to ground the present circuit, positive and negative third rails will be used. These will be located both on the same side and outside of the running rails. They are the under running type and will be placed one above the other. This type of third rail is inherently easier to protect and hence more suitable for yard work. Considerable care has been taken by the operating engineers in laying out the third rail location to eliminate the necessity of the third rail shoes approaching the rail from the side as, for instance, might occur at a cross-over. This eliminates the need for side incline rails at such points.

Due to its required height and desired clearance from steam locomotive steps and cylinders the third rail has been located at an exceptionally great distance from the track. If it were permissable to ground one side of the locomotive power supply requiring only one-third rail and using the running rails as the return circuit the third rail could be brought considerably closer to the running rail. This would be desirable as it would permit operation at closer quarters.

The relative locations of the third rail shoes are shown on the locomotive outlines. As there are some special considerations involved in their arrangement they may well be noted here. It will be seen that there are two shos, one positive and one negative on each truck, to facilitate bridging necessary gaps in the third rail. They are located on different horizontal planes. The end view shows the shoes on the right in the operating position while those on the left are raised. It is necessary that the raising and lowering of the shoes be controlled from the operating compartment of the locomotive in order to meet certain clearance restrictions.

Much credit is due the engineers of the Carnegie Steel Company for undertaking this record installation, which represents an interesting achievement in steel mill railroad electrification.

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Pressure oiling systems for worm reduction gears are described in a leaflet issued by the De Laval Steam Turbine Co., of Trenton, N. J. Ordinarily, speed reducers of this type are lubricated by a splash system, but in heavy service at high speed, a pumped supply is preferable, as it insures adequate lubrication under all conditions, and but little power is required to pump and spray the oil, while cavitation and loss of lubrication, and harmful churning of the oil by the high worm speed, are avoided. The oil is delivered to spray nozzles located on either side of the contact of worm wheel and worm, and to the worm and shaft bearings. Ordinarily, the pump is attached to the gear casing and driven from the worm shaft, drawing the oil through a strainer in the oil reservoir in the lower part of the gear casing. The pressure in the oiling system is controlled by an automatic release valve, which saves pumping against excessive heat at high speeds.

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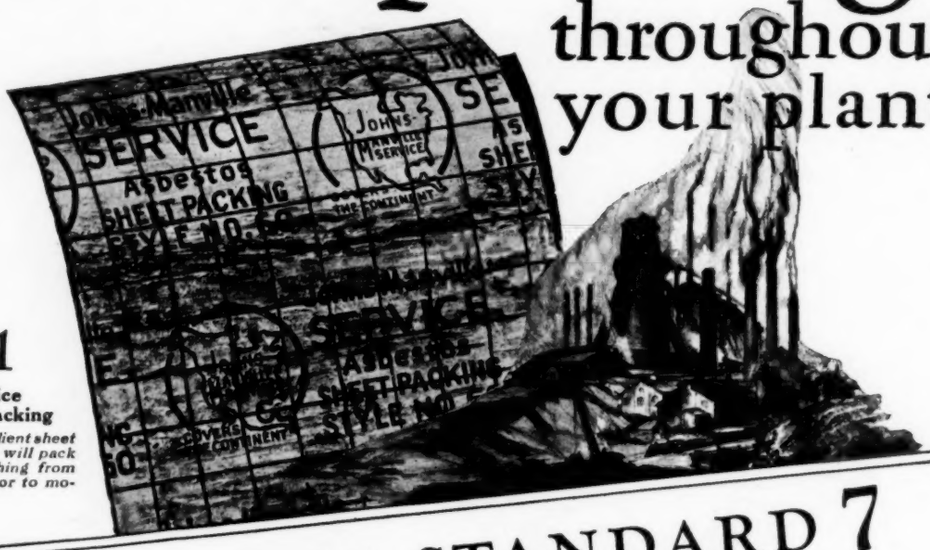


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